Project Number: 1-14129.07

Mangawhai WWTP Balance Tank

17 September 2020

CONFIDENTIAL

Concept Design

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Revision Details

Revision	Details
1	Released for client discussion
2	Amended costing after meeting with Thomas Lewis and Andrew Springer Amended programme following BC preparation

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This report ('**Report**') has been prepared by WSP exclusively for Kaipara District Council ('**Client**') in relation to Mangawhai Waste Water Treatment Plant (WWTP) Concept Design ('**Purpose**') and in accordance with the offer of service dated 17 June 2020. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

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1 Background

The Mangawhai CWWTP was completed in 2010 to treat the wastewater from the community of Mangawhai and Mangawhai Heads. This has produced a high-quality effluent since construction and has resulted in the Harbour Waters achieving a healthy, clean condition. When the plant was first connected 1250 properties were connected to the system. Today that number is over 2000, with 3000 expected before 2030.

At the recent workshop regarding Mangawhai community wastewater scheme, it was identified that there are a number of catchment flooding issues that are occurring. These have been identified as Jack Boyd Drive PS (PS-K) and Outfall PS. At the former there are overflows of untreated wastewater, whereas at the latter, the emergency storage is being used in wet weather conditions, with the potential to spill to harbour. Confirmation is required on whether this is permitted under the resource consents.

The Mangawhai area is experiencing rapid growth, with a prediction of 3 x current population by 2043. This means that a number of wastewater assets, particularly to the North of the catchment, including Jack Boyd Drive PS, will require upgrade. The impact of growth is being modelled to determine a plan of upgrades, but a fully calibrated model is not expected until 2021.

The scale of these upgrades and necessary capacity are currently unknown and not in the anticipated budget. To reduce the impact and frequency of spills in the immediate term, it is proposed that the pumps at Outfall PS are uprated to pass 100 l/s from their current 70 l/s. As the CWWTP is unable to treat more than 70 l/s, being restricted in the CASS decant system, and transfer to farm effluent pump main, it is proposed to take and store the excess flow for a period to the treatment works to reduce pressure on the network.

All future scenarios for the CWWTP require additional reactors for treatment. Therefore, it was considered at the workshop that a new balance tank shall have the same dimensions and be suitable for repurposing as a reactor in the future.

Controls will also be required to prevent overflowing of the balance tank that will, when full, limit flow from Outfall PS to a sustainable 70 l/s. This approach will enable more flow from Outfall PS to be passed at peak wet weather events, and potentially allow an increase in pass forward flow from Jack Boyd Drive PS to reduce flooding risk. After network modelling is complete and future flows understood, the full CWWTP upgrade can be implemented with a new resource consent for discharge that can manage all flows. This will then enable upgrades as needed to the wastewater network. However, this is anticipated to only be available in 2028. This proposed upgrade will provide an immediate fix to the catchment flooding by provision of future proofed assets.

This document outlines the proposed works including sketches, high level cost (for budgeting purpose) construction programme, and the reasons for the design selected to support the KDC business case.

2 Previous information

The following documentation has been provided by KDC and used as the basis for this report:

- General Drawing Arrangements
- Geotechnical Investigation (2013)

The documentation is provided in Appendix A

3 Site Visit

A site visit was performed by WSP Engineer Eros Foschieri on the 02 July 2020. The visit included only for a visual assessment of the site.

Photos of the site visit are included in Appendix B of this report.

4 Design

The proposed works are shown on the layout plan below and include for:

- Outfall Pump Station Upgrade
- Inlet Works
- Balance Tank
- Other modifications- odour, tank wash water

Figure 1 - Proposed Works, Layout Plan

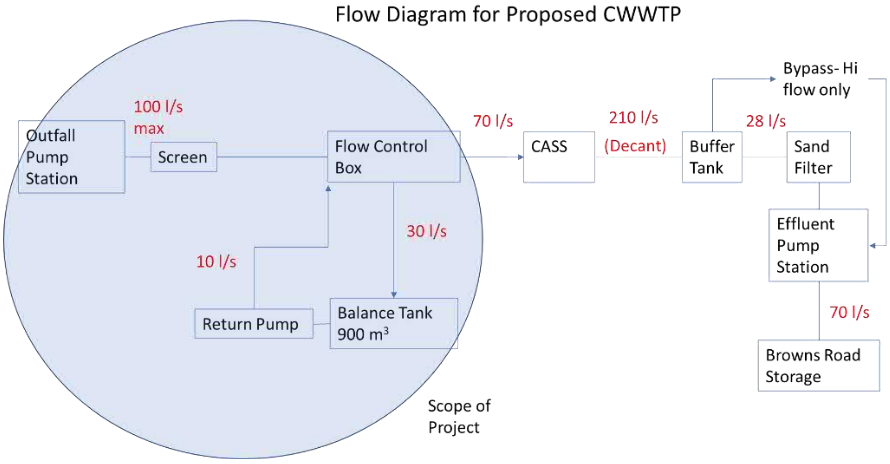

Figure 2 – Flow Diagram for proposed works

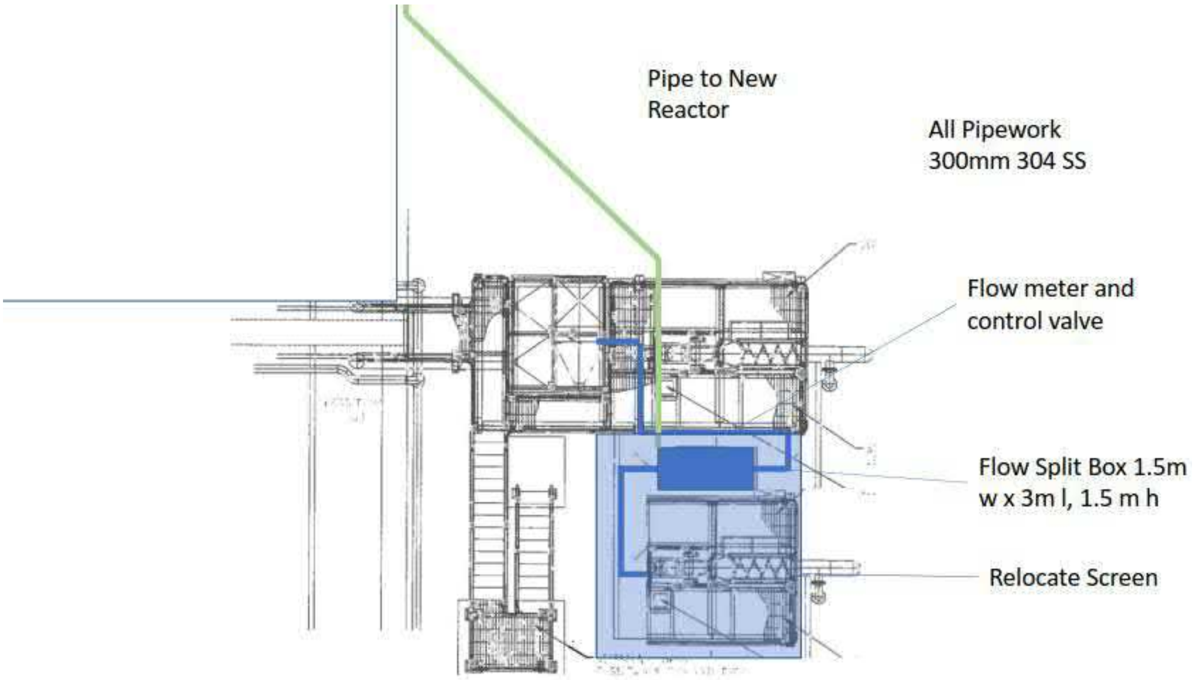

Figure 3 - Relocated Screen

4.1 Pump Station Upgrade

It is understood from Broadspectrum that larger pumps can be installed in the Outfall PS with only minor modifications to the controls. 2 New transfer pumps for 100 l/s will be required.

4.2 Inlet works

The inlet screen is suitable for 100 l/s. currently it also takes the return site water at about 10 l/s, which will mean that at peak flows the capacity of the screen may be exceeded and the manual bypass used for some a small proportion of the flow. This requires operator intervention after a storm event.

An alternative is to divert the return flow to the flow splitter box so lowering the flow at the screen. This has not been included in the cost estimate and it will be discussed with KDC at the detailed design stage.

The hydraulic calculation (summarised in Appendix C) confirmed that the current gradient is not sufficient to accommodate the proposed flow split. Additional head will be achieved by raising the screen by 600mm from its current elevation.

The raising of the screen is a complex activity if in the current location and would most likely require the inlet to be out of operation for over 12 hours. This is deemed to be impractical as even in dry weather, over 600 m^3/d arrives at the treatment works.

It is therefore intended to extend the steel structure over the skip area. This will integrate to the existing structure, reducing total steel required, with new support legs over the skip. By being at a higher level, this enables screenings to drop into the skip below.

The storm splitter box will be located next to the screen at a lower level and consists of a stainless-steel box with weir. The overflow from the weir will gravitate to the new balance tank through a 300mm pipe.

The pass forward flow will be controlled after the splitter by a flow meter and actuated gate valve arrangement. A minimum straight pipe length is required of 3 m for this to operate. Flow will reconnect to the base of the current flow splitter.

Odour can be generated at the inlet works at the screen, flow splitter and overflow chamber. A new activated carbon odour filter will be installed near the inlet works to extract and cleanse the air to prevent customer nuisance. This will require periodic replacement of the carbon, every 1-2 years.

To relocate the screen, it is necessary to modify the inlet pipework and relocate the flow meter. As this pipe is flanged connections, it is relatively straightforward.

It is recognised that the changeover of the screen might be a complex process and will involve electrical disconnection, recabling, disconnection of incoming pipe, removing pipework from the structure, refitting new pipework, relocating the screen and recommissioning. The challenge for this activity is the time and capacity of storage at the outfall pumpstation. It has been assumed that in dry conditions 6 hours is available before flow must be turned, but if the activity will take longer, or storage is less, an alternative approach will be used. The alternative is to purchase a second screen, making the current screen redundant. The current screen is expected to have only 4 years of asset life remaining and may require replacement before the next upgrade in 2028. This alternative simplifies the changes required to be made, and consists of 2 pipe connections, with all other pipework being preinstalled.

4.3 Balance Tank

The proposed tank is a precast concrete tank of the same dimensions as a current reactor. This means that once the future configuration of the plant is decided and future flows predicted by the catchment modelling, this tank can either remain as a balance tank or be easily modified to be a treatment reactor.

The edge of the site has a drainage ditch which will require diversion or culvert for approximately 30m, which can be undertaken when the earthworks for the tank are made.

The geotechnical desktop review shows no significant hazards that will warrant extensive foundation works and construction may therefore be similar to the existing tank. Geotechnical investigations will be required to be confirm as part of the detailed design.

The tank shall have no internal baffles as these will lead to poor cleaning of the balance tank. It shall have a central floor channel draining to a sump at the far end. This enables incoming flows to assist in flushing solids from the inlet to the return pumps for removal. A hydrant will be provided on an access platform at the inlet to assist in operational cleaning after use.

The tank will usually be empty, but will fill in storm conditions. This will be automatically emptied by a duty/standby dry mounted submersible pump located at the end of the tank. This is similar to the RAS pumps on the existing tank. The return flow will be discharged to the storm split box, but only operate when the inlet flow meter reads low or no-low. By automatically emptying the tank, wastewater does not have the opportunity to go septic and generate odours. Periodic manual cleaning will also assist in the management of odours.

4.3.1 Geotechnical Consideration

The desktop geotechnical study is attached in Appendix D of this report and included for the following:

- *Desktop review of the geotechnical investigation report for the existing plant and its relevance*
- *Compliance with the latest building code;*
- *Provide assessments on of potential geohazard and constraints for the proposed development;*
- *Should it be needed, propose the required geotechnical investigation; and,*
- *Preparation of this Stage 1 Preliminary Geotechnical Appraisal Report.*

We consider that the site is generally suitable for the proposed development of another balance tank. However, the presence of soft silty clay deposits which were recorded by the historical CPT at shallow depth should be considered as part of the due diligence process.

Therefore, for the proposed future developments, at least another three CPTs are required to be placed to refusal with two of them within the footprint of the new proposed tanks structure with another one to the northwest of the existing intermediate storage tank.

These new CPT readings together with the historical boreholes from Tonkin & Taylor will be used to develop for a new geological model which runs from northeast to southwest direction. As we were unable to obtain these historical CPT data readings for our processing, the new CPT data will be used to assess the liquefaction potential for the new development.

4.3.2 *Structural Consideration*

The shape and dimension of the tank are the same as the existing CASS reactor, so this can be utilized in the future as a potential reactor. The initial reinforcement detail and the wall thicknesses have been calculated as part of this concept design. The calculations and assumptions are summarised in Appendix E. An isometric view of the tank is shown below.

The balance tank is rectangular (approximately 24m x 8m x 6m) with several internal baffle walls. The longer perimeter walls have thicknesses of 450 mm while the shorter perimeter walls have thicknesses of 350 mm. The internal walls and the base slab are 200 mm thick.

The longer perimeter walls were designed as free-standing cantilevers while the shorter perimeter walls were assumed to be two-way spanning.

Critical structural information is shown in the table below.

Table 1 - Critical Structural Information

Item	Value
Importance Level	3
Design Life	100 years
Soil Classification	C
Ground Bearing Capacity	300kPa (ULS)
Concrete Grade	40/50 MPa
Reinforcement Grade	500MPa

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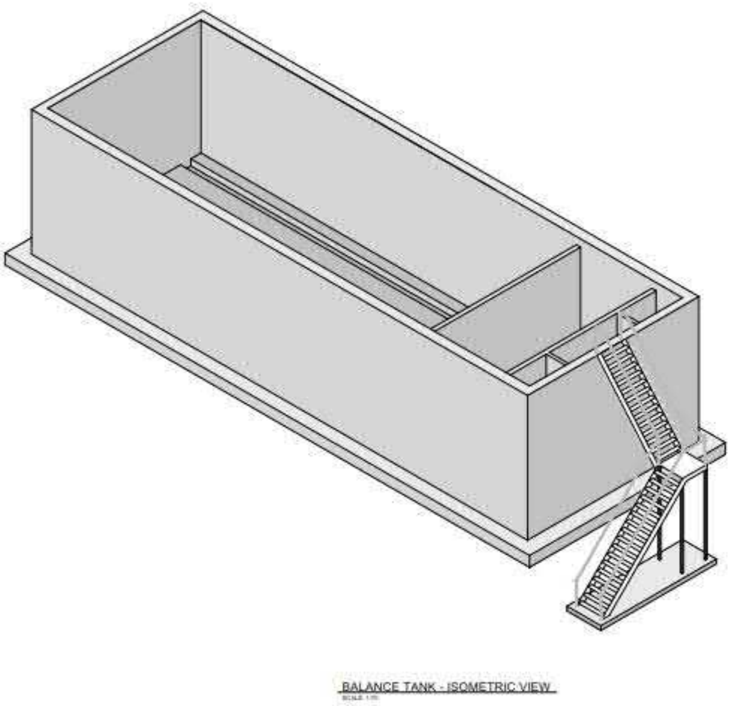

Figure 4 - Balance Tank, isometric view (internal baffle not included in the final output)

4.4 Other Modifications

As identified above the CWWTP does not have the capacity to treat more than 70 l/s. This means that when the balance tank is full, it is necessary to communicate to the Outfall pump station to slow the pumps down to only deliver 70 l/s. If this does not occur, the balance system will fill with water and more flow will pass to the treatment process, eventually resulting in overflow of downstream processes. A communication system will be developed to link these systems.

The skip for screening material is currently to one side of the inlet works structure. It is proposed, with the raising of the screen to put the skip under the screen. Some slab and drainage modifications may be required.

5 Construction Staging

The construction of this system needs to be planned to ensure that wastewater can enter the plant and continue being treated. It is anticipated that the storage at the outfall pump station may be used and this will at night enabling up to 6 hours in dry conditions with no flow to the treatment works when invasive work is undertaken. Most construction will require no interruption of the operation of the existing works.

- Stage 1.
  - Finalise contractor design elements, shop drawings
  - Procurement of panels, steel work, m&e equipment
  - Lodge consents required for construction.
  - Install new odour filter adjacent to inlet works. Use temporary connections.
  - Isolate and Remove odour bed as on site of new tank.
- Stage 2.
  - Prepare groundworks for new balance tank.

  - Provide new drain and site fence. May be a temporary fence depending on construction techniques and area required.
  - Temporary connection of odour plant to existing inlet.
- Stage 3.
  - Preparation of tank foundation
  - Install Tank base
- Stage 4
  - Construct balance tank walls and seal base edges
  - Install Stair access.
- Stage 5.
  - While testing water tightness of balance tank (approx. 2 weeks) install return pumps and pipework
- Stage 6
  - Install new inlet structure
  - Fabricate overflow weir box and pipework
  - Install pipework as far as possible including flow meter, valves and pipe to balance tank.
- Stage 7.- Screen relocation

  This stage requires a coordinated inlet shut down and adequate personnel and equipment to make the required changes in a limited time window.
  - Stop flow.
  - Disconnect electrical connections
  - Unbolt screen at flanges and remove redundant pipework
  - Install screen and connect to preinstalled pipework.
  - Repower screen
  - Return flow to inlet works.
- Stage 8
  - Commission flow control
  - Commission feedback control to outfall pump station.
- Stage 9
  - Replace pumps at Outfall PS.
- Stage 10.
  - Wait for rain to confirm operation. It is recommended that site is attended on first storm event to confirm operation is correct.

A preliminary overall project programme is presented below. The following assumption have been made in the preparation of the programme:

- The tender period has a two-week shut down for the contractors over the Christmas period. Actual tender time available is therefore 5 weeks.
- Construction period includes for Earthworks, procurement and manufacture of precast concrete and steel sections, installation, testing and commissioning.
- No time delays due to weather are allowed in costs. 2 weeks of delays are included in the programme.

- Procurement of precast tanks is less than 8 weeks from start of contract
- Procurement of structural steel is 8 weeks from start of contract
- No contingency is allowed in the programme.

Table 2- Preliminary Project Programme

Key Milestones	Forecast Date	Responsibility
KDC project approval	*30 September*	*KDC*
Detail Design Delivery	*16 December*	*Consultant*
Contract Document completion	*16 December*	*Consultant*
Detail Design Review	*16 December*	*KDC*
Tender issue	*21 December*	*KDC*
Contract Award	*22 March 21*	*KDC*
Construction Completion	*23 August 21*	*Contractor*
Commissioning Completion	*13 Sept 21*	*Contractor*

6 Costing

A rough order of costs (ROC) has been prepared based on the concept presented in this report. As shown in Table 2 below. A detailed summary is also provided in Appendix F. The ROC is derived from a schedule of standard rates, typical NZ construction costs and supplier information. Assumptions for programme and project cost estimates include:

- No significant geotechnical issues and construction is similar to existing assets.
- The existing screen can be relocated without damage within the time frame available. A risk item included in the risk register
- Outfall pump station pump replacement is a similar pump to existing and no other pump or pipe modifications are required.
- Current on site MCC, PLC, telemetry and SCADA have sufficient capacity for the additional functions (2 additional 5 kW drives, 1 flow meter, level instrument, actuated drive and remote link control system)
- No power upgrade to site is required.
- Bank will be reduced to level ground to 10 m from the balance tank.
- 50m of site fencing will be provided
- Drain channel at the current fence line will be replaced with 400 mm concrete pipe, buried to the side of the new balance tank.
- Sufficient wash water is available on site for tank cleaning.
- Additional consents will be obtained by the contractor with no delays.
- Rates selected for walls at Structures estimate based on area
- Assumed 10% of cast concrete volume is Steel weight
- Odour plant Cost assumed from similar projects for green dome with integral fan. Supplier price not received
- Assumed $15,000 of physical geotechnical investigation in design fees
- Assumed for shallow foundation, not piling
- Not allowed for a PS2 in design fees
- Access assumed via 1 staircase at the southern end - no allowance for rail on the perimeter of the tank
- No allowance in the fee for training of the operator after construction
- Assumed no retaining wall on the hill side will be required

Table 3 - Rough Order of Cost

Mangawhai WWTP		
Item	**Description**	**Total**
1	Preliminary and General	$ 275,156.83
2	Earthworks and Clearing	$ 82,470.00
3	Drainage	$ 16,550.00
4	Structures	$ 912,076.00
5	Landscaping & Entrances	$ 15,750.00
6	Piping, Pumps and Filtration	$ 144,338.13
7	Extraordinary Construction Costs	$ 25,600.00
8	Electrical	$ 154,000.00
9	Fees	$ 195,075.28
	Total	$ 1,821,016.23
	15% contingency	$ 273,152.43
	Final Estimate	**$ 2,094,168.66**

7 Project Risks

A number of key project risks have been identified at this early stage of the project and approach to minimise impact has been proposed as outlined in the risk register provided in Appendix G. Below we provided a list of the most significant risks:

- Geotechnical conditions.
  Ground conditions were identified in the previous geotechnical report as being inconsistent across the site. This could lead to the need for unbudgeted remediation or changes in design. Mitigation is provided by undertaking additional Geotechnical testing in the areas of construction to confirm local conditions.
- Bank stability.
  To build the new balance tank it is necessary to partially cut back the existing bank immediately outside of the site. Additional cost and time may be incurred if this bank is unstable and remediation is required. To mitigate this risk, the bank shall be assessed as part of the geotechnical studies
- Inlet screen.
  It is assumed that the existing inlet screen (11 years old) is in good condition and can be readily disconnected, moved and reconnected. Due to asset age it is expected to be serviceable for approximately 5 more years, and should be replaced when the next inlet upgrade is completed. The risk is that the screen is damaged during the transfer, or cannot be readily disconnected and reinstalled in the time window available for shutdown of the inlet flow. This will be looked at in detail in the design stage. These risks can be mitigated by the purchase of a new screen. This can be installed from new into the required location, with most of the pipework and commissioned while the existing screen is in use. This reduces risk of failure, damage, or delays. A new screen is estimated at $60,000.
- Capital funding.
  It is understood that there is a budget of $1.8m available for this financial year. The capital estimate, with no contingency is at this value, however, if risks are realised, the project budget may be exceeded. KDC are to consider how this may be managed. One consideration is that construction and commissioning are expected to pass into the 2021/2 financial year.
- Odour.

To enable construction the existing odour system must be removed and a new odour unit installed. This will result in a period with no odour management on the inlet. The new unit will be connected to new pipework to the new location of screen and flow control box, with the current flow split. It is assumed at this time that the odour filter can be installed adjacent to the inlet works and if, required can be connected with temporary flexi hose. The preliminary programme shows that this change over may occur in April, so the risk of customer complaints is lower than in peak summer.

- Tank cleaning.
  It is assumed that the balance tank will only be used occasionally, and that with the fall on the floor to a sump, manual cleaning of the tank using site washwater (effluent) can be undertaken. A platform is provided at the tank inlet for this purpose. Cleaning is necessary to prevent odour generation. However, if there is insufficient water volume and pressure for this activity additional improvements will be required. These may include increased water pressure booster, additional access and wash hoses, or in tank cleaning systems. The water pressure shall be assessed in design.
- Catchment flooding.
  The intention of the balance tank is to enable at peak storm flows to pass more flow to the CWWTP and temporarily store the water until after the storm event. This will provide additional buffer capacity to the network compared to the current configuration. However, no modelling of the network has been undertaken yet (currently underway and estimated completion is within a year time) thus the size of the tank has been purely based on the capacity of this to be reused in the future as additional CASS tank (like for like of the existing tanks).
  Should a greater flow be required to be passed forward in the short term, a second balance tank may be required

Appendix A
Existing CWWTP Information

REPORT

EARTH TECH CONSTRUCTION PTY LTD

Mangawhai Waste Water Treatment Plant Geotechnical Investigation Report

Report prepared for:
EARTH TECH CONSTRUCTION PTY LTD

Report prepared by:
TONKIN & TAYLOR LTD

Distribution:

EARTH TECH CONSTRUCTION PTY LTD	4 copies
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June 2006

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1 Introduction

Tonkin & Taylor Ltd (T&T) were engaged by Earth Tech Construction Pty Ltd to undertake a geotechnical investigation for a proposed waste water treatment plant. The treatment plant is proposed as part of a wider scheme to install a reticulated waste water system for the Mangawhai Heads and Mangawhai Village areas.

T&T have also undertaken a geotechnical investigation for the reticulation and pump station portion of the project and preliminary geotechnical reporting on several proposed disposal sites.

2 Site conditions

The site of the proposed treatment plant is located northeast of Thelma Road immediately southwest of the Mangawhai Heads Golf Club. Access to the site is obtained off Thelma Road. The location for the proposed treatment plant is shown on drawing 23428.001-01 in Appendix A of the report.

The site is currently covered in a variety of regenerating native and exotic vegetation including pine trees, punga and ferns. The site is typically gently sloping with some moderately sloping undulations. The site is wet in lower lying areas with surface water present over parts of the site.

3 Geological conditions

The published geology for the area, New Zealand Geological Survey – Whangarei (Scale 1:250,000, ref 1) indicates that the site is underlain by Quaternary aged fixed dune sands.

4 Proposed development

We understand the proposed treatment plant consists of 5 main structures. These include:

- 3 CASS concrete rectangular tanks which measure approximately 20 m by 7 m. The internal wall of each tank is shared to give an overall footprint of 20 m by 21 m. The tanks are 5 m in height and are set 1 m into the ground. These tanks are proposed to be located in the north east corner of the site where BH2 was drilled.
- A sludge thickening concrete tank measuring 13 m in diameter and 5 m high located immediately to the west of the CASS tanks and just south of the NW piezometer (PZ2). Foundation preparation for this tank may include minor cut to fill earthworks to level the immediate area.
- A belt press building situated south of the sludge thickening tank. We understand this building is to be founded on a concrete slab and is approximately 13 m by 6 m in size.
- A steel hoop tank supporting an internal bladder of 18 m diameter. We understand the tank is up to 6 m high and sits on a concrete ring footing. The tank is proposed to be located in the southwestern corner of the site.
- A main control building for the site contains offices, a switchroom and blower room. This building is to be of flexi-clad construction on a concrete slab with

dimensions of 20 m by 9m. We understand it is to be located 6 m south of the CASS tanks and the 20 m side is to run parallel to the 20 m side of the CASS tanks.

5 Field Investigation

The field investigation was undertaken from 15 – 17 May 2006. It comprised four boreholes (BH1-4) with Standard Penetration Tests (SPTs) undertaken at regular intervals. The boreholes extended to between 7 m and 10 m depth. Two standpipe piezometers were installed to monitor the long term water level across the site (PZ2 & PZ3). The piezometers were installed in BH2 and BH3 to 9 m depth, with the bottom 2 – 3 m screened and the upper 6 m sealed with bentonite.

Five Cone Penetrometer Tests (CPT1-5) were also undertaken across the site. These were put down to between 10 m and 15 m depth. The locations of the boreholes, CPT's & piezometers are shown on drawing 23428.001-01 in Appendix A of the report.

6 Subsurface conditions

6.1 General

The geotechnical investigations undertaken at the site encountered a variety of materials and have generally confirmed conditions described in the Geological Map (Ref 1). As expected, much of the area is underlain by quaternary sand deposits with the northern portion of the site (BH4) encountering old estuarine silts and sands.

The materials encountered in the recent investigations are generally described as follows:

Topsoil

This included organic and humic debris and sandy silt. The topsoil was generally dark brown, wet to saturated and varied in thickness from 0.1 m to a maximum thickness of 0.5 m (BH4).

Quaternary sands

Quaternary sands were encountered over much of the site and to considerable depth. The sands were often silty, orange brown with occasional sandy silt lenses. The sands were typically loose to medium dense with SPT values ranging from 5 to 21. The sands were typically loose near the surface becoming denser with depth. We expect the sands are old dune deposits. These sand deposits are widespread over the Mangawhai area.

Estuarine and lacustrine deposits

Estuarine deposits encountered in BH4 included loose fine to medium grained sands and firm high plasticity silts and clays. SPT 'N" values ranged from 2 to 9 to 5 m depth becoming very dense at 6 m depth (SPT ' N'>50). These materials are likely to have been deposited from a water body behind the dunes. The materials consist of clays and silts, and are soft to very stiff and generally highly plastic. Some organic material was present in the materials recovered, indicating that plant material was also deposited with the fine grained material. The estuarine deposits were mostly encountered in BH4, with BH1-3 almost consisting entirely of sandy material.

Bedrock was not encountered during the investigation; however we expect that Waitemata Group siltstones and sandstones are likely to underlie the above soils at depth.

6.2 Groundwater

During the investigation, saturated materials were encountered at between 5.4 (BH2) and 6.8 m (BH3 and BH4). Two piezometers were installed during the geotechnical investigation, in BH2 and BH3 respectively (PZ2 & PZ3).

Groundwater levels have been monitored and recorded following the investigation and are detailed in the following table.

Table 1: Ground water levels

Date	Ground Water Level (m)	
	PZ2	PZ3
07 June 2006	4.1	6.2
15 June 2006	4.5	6.6

We do not expect these levels to vary significantly from those in the table which were recorded following a prolonged wet period in early winter when groundwater levels would be expected to be high.

7 Geotechnical issues and recommendations

7.1 General

Recommendations and opinions contained in this report are based upon data from boreholes and CPT's and surface exposures. Inferences about the nature and continuity of subsoil away from the subsurface investigation sites are made but cannot be guaranteed.

The following geotechnical issues have been addressed as part of the report:

- foundation options
- settlement
- retaining wall parameters
- earthworks
- pavement design
- seismic category

7.2 Foundation Options

The loose to medium dense sands and firm to stiff silts encountered on the site are expected to be suitable for founding the proposed structures on shallow foundations. The structures can be founded on either shallow pad/strip footings or on a shallow raft foundation system. All foundations should extend to a minimum of 0.5 m depth and be founded below any topsoil or organic soils.

An allowance should be made for sub-excavation of any unsuitable material encountered near the surface. This is expected to comprise decomposing organic material and topsoil which is expected to be encountered between approximately 0.2 and 0.5 m depth.

Following excavation of each platform the exposed surface should be proof-rolled using a vibrating plate or smooth drum roller. This proof-rolling should be observed by a competent Engineer and any soft spots should be subexcavated and backfilled with compacted sand.

For foundations on the proof rolled subgrade surface, a geotechnical ultimate bearing capacity of 300kPa may be used for foundation design. This corresponds to factored (Ultimate Limit State) and allowable bearing capacities of 150kPa and 100kPa respectively.

Some minor cut to fill earthworks may be required on the site. Recommendations for the compaction of fill materials are provided in section 7.6 of the report.

7.3 Settlement

We understand that the proposed structures are to impose the following maximum applied floor loads (unfactored cyclical working loads):

- Three combined CASS concrete rectangular tanks - applied loading of 50 kPa
- Sludge thickening tank (concrete) being 13 m diameter and 5 m high - applied load of 50 kPa
- Belt press building of dimensions 13 m x 6 m - applied loading of 30 kPa
- Steel hoop tank supporting an internal bladder of 18 m diameter - applied loading of 60 kPa
- Main building (including offices, switchroom, blower room etc) founded on a concrete slab of 20 m x 9 m dimension - applied loading of 30 kPa.

The soils that underlie the site are typically sandy with moderate permeability. In areas where silts were encounted intermediate sand lenses are common with horizontal drainage paths being typically less than 2 m apart. Accordingly we expect that settlements at the site will generally occur over a short period following the application of the first full loading. Based on the above loadings, which we understand will be cyclical for some structures, we have completed a settlement analysis of the largest tank (CASS) which is located in an area where soft estuarine silts and sands were encountered (BH4). The analysis indicates that settlements of approximately 50 mm are expected. Differential settlements of less than 1:300 are expected which we understand are within normally accepted construction tolerances for these types of structures. This should be confirmed by the tank suppliers.

7.4 Ground retention and temporary excavations

Excavations of up to 1 m depth are likely to be undertaken for a number of the structures. In addition some minor cuts are likely to be required when forming the access road into the treatment plant. Table 2 below provides applicable retention design parameters.

Table 2: Retaining wall design parameters

Soil Type	Unit weight (kN/m³)	Effective friction angle (degrees)	Effective cohesion (kPa)	Ko
Firm to Stiff Silts	18	28	0	0.53
Loose Sands	18	30	0	0.5
Medium Dense Sands	18	32	0	0.47

The design of retaining walls will need to incorporate the following (if appropriate)

- surcharge effects
- water pressures
- compaction pressures.

Retaining walls should be detailed to include a perforated drain behind the wall and a 200 mm thick clay cap to prevent surface water infiltrating behind the wall.

In other areas temporary and permanent batters may be utilised. The water table is relatively low (> 4m depth) at the site so batters and walls are likely to be above the ground water table. The stability of excavations and batters in sand (above the water table) will depend on the moisture content and density of the sands. Moist dense sands are likely to provide short term stability and stand sub-vertically. However, loose dry sands are likely to lie back to a more stable repose angle. The condition of the sand will need to be considered as excavation proceeds to prevent the risk of collapse. We recommend that excavations (less than 3 m depth) be generally battered back at 1V:1.5H in the short term and 1V: 2.5H in the long-term.

7.5 Pavements

We understand that an access road will be constructed from Thelma Road entering the site from the southwest. The road will be 4 m wide and will cater for 15t trucks and domestic vehicles.

All topsoil and loose materials should be excavated prior to pavement construction and the exposed subgrade proofrolled with a vibrating smooth drum roller. This proof-rolling should be observed by a competent Engineer and any soft spots should be subexcavated and backfilled with compacted fill. We recommend that pavements founded in the natural silt and sandy soils on the site be designed assuming a subgrade CBR of 4.

7.6 Earthworks

Some minor cut to fill earthworks may be undertaken to level the building site and form the accessway. We recommend that fill materials be compacted to engineering standards in accordance with the specifications below. If additional fill is to be placed then the materials should be compacted in layers of less than 200 mm thickness and conditioned to the appropriate average water content. All organic material should be removed from the fill prior to placement. Compaction of each layer of locally sourced fill should be sufficient to obtain the following standards:

Either:

(a) For soils with more than 95% passing the 425μm sieve after compaction (**silts & clays**) the test criteria are

- average vane strength over 10 consecutive readings shall not be less than 120 kPa with no individual reading less than 110 kPa
- the air voids shall not exceed 7%.

Or:

(b) Soils with less than 95% passing the 425μm sieve (**sands & gravels**) after compaction the test criteria are:

(i) In-situ CBR > 6 (or Clegg CIV > 10)

The in-situ CBR shall be measured by using NZS 4402, Test 6.1.3 and in accordance with

(ii) The air voids shall be measured by nuclear densometer and shall not exceed 7%.

A minimum of one in-situ density test (to determine air voids content) and a minimum of 10 shear vane/scala/clegg readings should be undertaken per 1,000 m³ (or 1 m lift) of fill with a minimum of 1 per 100 m² of fill per 200 mm lift.

Appropriate test methods for in-situ density (air voids measurement) are outlined below:

In-situ Density:	NZS 4402:1986 test 5.1.1 or
	ASTM D2922 (Nuclear Densometer)

7.7 Liquefaction

The soils encountered at the site typically comprise fine grained silty sands and sandy silts. These soils have grain sizes close to the lower end of the particle size distribution envelope that can potentially liquefy during a seismic event. The ground water table is expected to be low (> 4 m depth) and the seismic accelerations for the Mangawhai area are also low. Based on the above and our review of the borehole and CPT data we consider the risk of liquefaction occurring on the site to be low.

7.8 Site seismic category

Seismic accelerations to be resisted by a structure are dependent upon the stiffness of the underlying soil / rock. Soft soils have the potential to amplify ground accelerations, requiring structures to be designed to resist a higher seismic coefficient. In terms of NZS1170 Section 5:2004 (ref 2), the site subsoil category should be taken as Class C (shallow soil sites).

8 Conclusions

Based on the information from the site investigation, and our experience with similar materials, we summarise our conclusions and recommendations for the proposed development as follows:

- The site is underlain by up to 0.5 m of organic topsoil overlying loose to medium dense sands and firm to stiff estuarine silts.
- Groundwater levels were recorded at depths typically greater than 4 m depth below existing ground level
- We recommend that structures be founded on shallow pad/strip footings or shallow rafts founded in the natural soils below any fill or topsoil. Shallow foundations can be designed assuming a geotechnical ultimate bearing capacity of 300 kPa which equates to an ultimate limit state (ULS) and allowable capacities of 150 & 100 kPa respectively.
- Once the site is stripped of topsoil and excavated to the design levels, we recommend that the site be proof rolled to consolidate any loose layers and identify and areas that need excavating out and replacing.
- Based on the loadings provided, and subject to proof rolling, we expect total settlement to be less than 50 mm with differential settlement greater than 1:300. The majority of settlement is likely to occur during the construction period or following the first full loading cycle.
- Retention design parameters and recommendations for excavations are provided in section 7.4 of the report.
- Pavements can be designed using a subgrade CBR of 4 as per section 7.5 of the report.
- Some minor earthworks may be undertaken on the site. Specifications for fill placement are provided in section 7.6 of the report.
- In terms of NZS1170 Section 5:2004 (ref 2), the site subsoil category should be taken as Class C (shallow soil sites).

9 Applicability

This report has been prepared for the benefit of Earth Tech Construction Pty Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

TONKIN & TAYLOR LTD

Environmental and Construction Consultants

Report prepared by:	Authorised for Tonkin & Taylor by:
....	C J Freer ....
Scott Wilkinson/John Leeves	Chris Freer Project Coordinator

sjww

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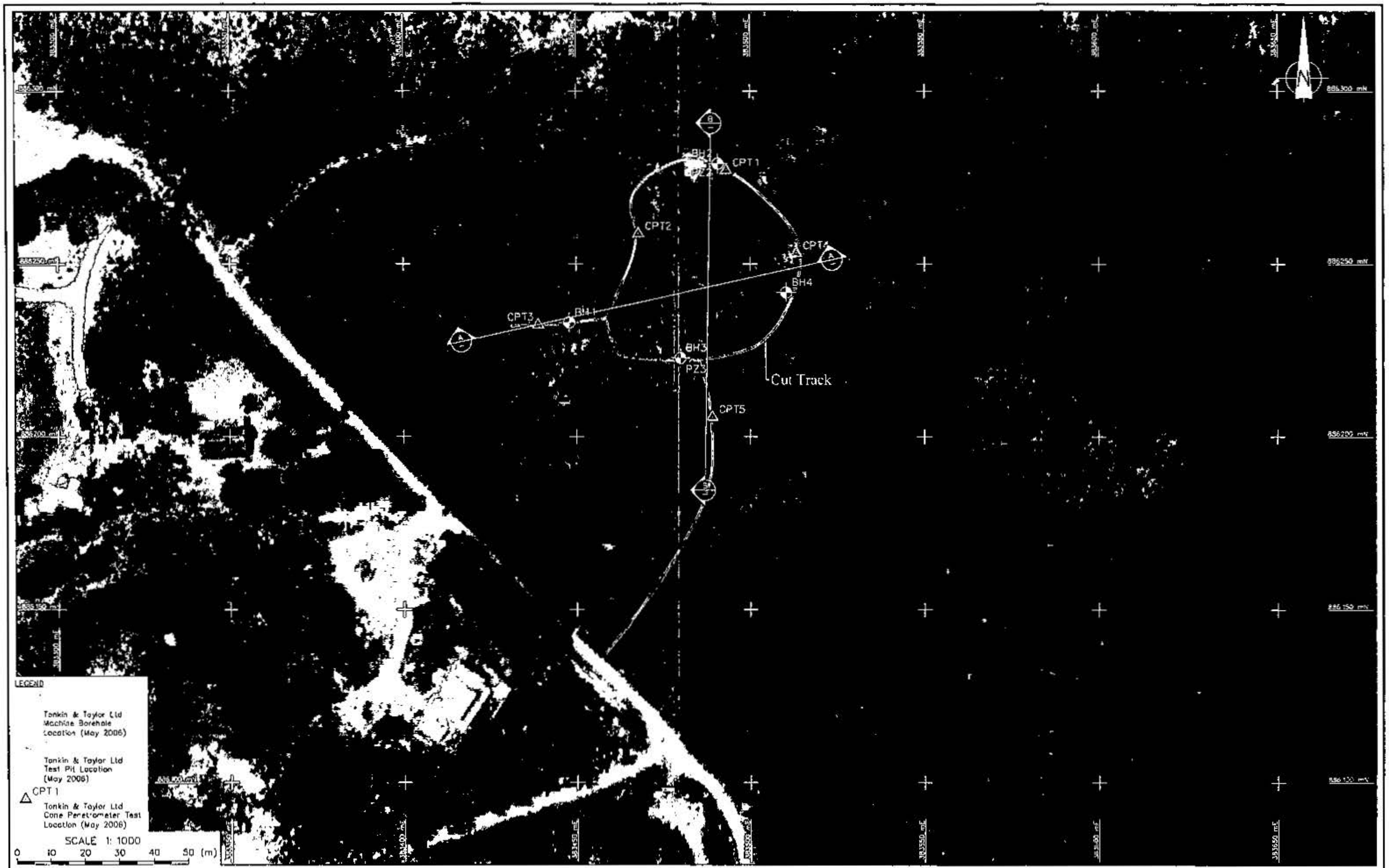
10 References

1. New Zealand Geological Survey (1961). *Geology of Whangarei.* Department of Scientific & Industrial Research.
2. NZS 1170.5:2004. Code of Practice. *Structural Design Actions – Part 5 Earthquake Actions. DR 1170.4/PPCD 8.* Standards Australia / Standards New Zealand. DRAFT No 8.

Appendix A: Site plan & Geological Section



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				DRAWN :	AMM	May.06
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				DRAFTING CHECKED :		
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				APPROVED : NOT FOR CONSTRUCTION This drawing is not to be used for construction purposes unless signed as approved		
0	First Issue					
	REVISION DESCRIPTION	BY	DATE	COPYRIGHT ON THIS DRAWING IS RESERVED		

NOTES:

1. All dimensions are in metres unless noted otherwise.
2. Base drawing supplied by: Geo Smart Ltd (Job Title Mangawhai Ortho Resupply, Job Number PGRM 1617)

REFERENCE :

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Environmental & Engineering Consultants

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Tel. (09) 355 6000 Fax. (09) 307 0265
Email : auck@tonkin.co.nz
www.tonkin.co.nz

CLIENT, PROJECT
EARTHTECH
MANGAWHAI SEWER PROJECT

TITLE
GEOTECHNICAL INVESTIGATION
FILED INVESTIGATION PLAN

SCALES (AT A3 SIZE) 1: 1000
DWG. No. 23428.001-01
REV. 0

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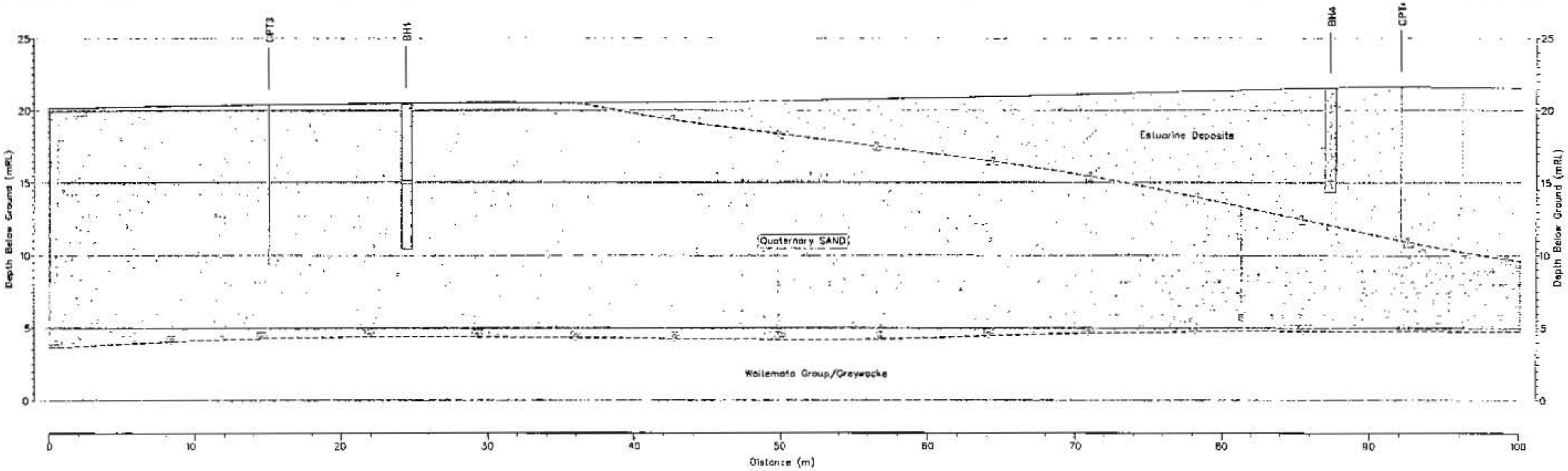

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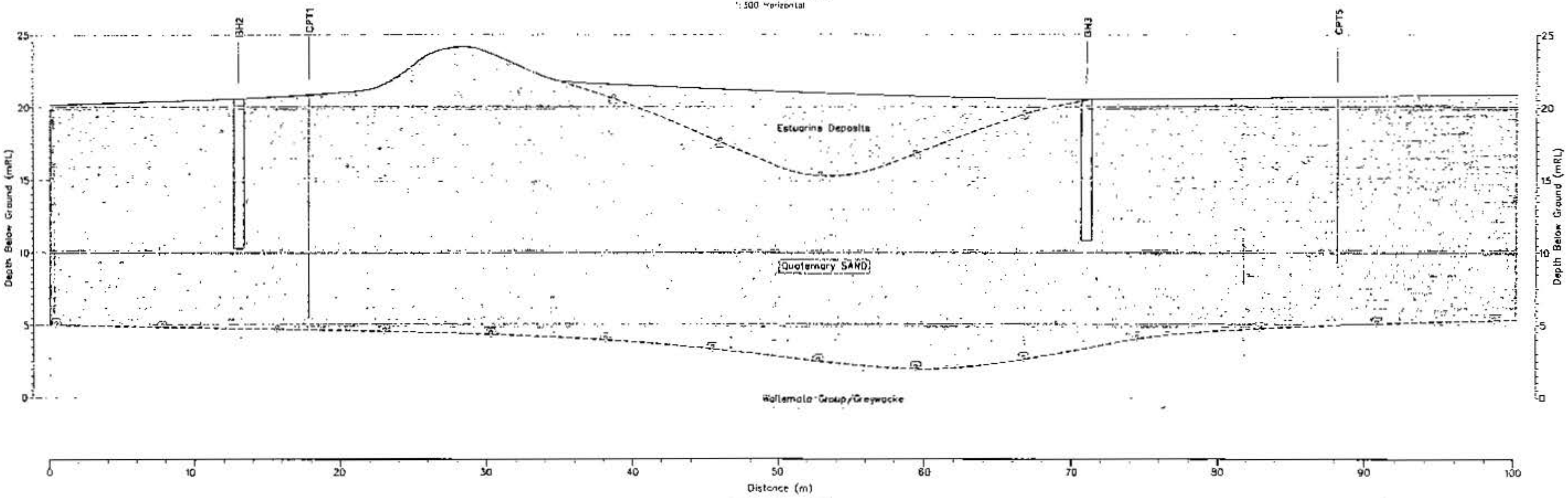
1:300 Horizontal



SECTION B/01
Scales
1:300 Vertical
1:300 Horizontal

SCALE 1:300
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DRAWN :	RBS	Sep.05
DESIGN CHECKED :		
DRAFTING CHECKED :		
CADFILE : P:\23428\2342..\23428.001-01		
APPROVED :		

NOT FOR CONSTRUCTION
This drawing is not to be used for construction purposes unless signed as approved

NOTES:
1. All dimensions are in metres unless noted otherwise.

GEOLOGICAL LEGEND:
- --?-- Inferred Geological Contact
- ▨ Estuarine Deposits
- ▨ Quaternary SAND
- ☐ Waitemata Group/Greywacke

REFERENCE :

Tonkin & Taylor
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CLIENT. PROJECT
EARTHTECH
MANGAWHAI SEWER PROJECT

TITLE
GEOTECHNICAL INVESTIGATION
GEOTECHNICAL CROSS SECTIONS

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Appendix B: Borehole Logs

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH1
Hole Location: GPS mark 39
SHEET 1 OF 1

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 15/5/06
HOLE FINISHED: 15/5/06
DRILLED BY: LDE
LOGGED BY: SJWW CHECKED: JRL

GEOLOGICAL GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	CORE RECOVERY	METHOD	TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	STRENGTH/DENSITY CLASSIFICATION	ENGINEERING DESCRIPTION SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL					MH	VSt	SILT, some fine sand, moderately to highly plastic, stiff to very stiff, some roots in top 200mm, grey brown.
QUARTERNARY SANDS		AUGER					NO RECOVERY.
				1	MH		SILT, some fine sand, some clay, very stiff, highly plastic, wet, light grey (very), mottled light orange brown.
					SM	L	SAND (fine), loosely packed, moist to wet, occasional black carbonaceous specks throughout, light orange brown.
	450	SPT	2 3 2 N=5	2			
	1050	AUGER		3			
	450	SPT	2 5 4 N=9				
BOX 1	1050	AUGER		4			
	450	SPT	3 4 5 N=9	5			
	1050	AUGER		6			
	450	SPT	2 4 6 N=10				- becomes very light brown, white and black specks, saturated.
	1050	AUGER		7			
BOX 2	150	SPT	3 4 8 N=12	8		MD	- black carbonaceous material for 50mm (1mm thick layers). - becomes orange brown, some silt and tightly packed. - becomes loosely packed, minor silt.
	1050	AUGER		9			- becomes tightly packed, light brown with black carbonaceous specks and streaks, silty. - minor silt, loosely packed.
BOX 3	450	SPT	3 5 9 N=14	10			**END OF BOREHOLE AT 10.0m**

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH2
Hole Location: GPS mark 40
SHEET 1 OF 1

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001
CO-ORDINATES mN
mE
R.L. m
DATUM
DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A
HOLE STARTED: 15/5/06
HOLE FINISHED: 15/5/06
DRILLED BY: LDE
LOGGED BY: SJWW
CHECKED: JRL

GEOLOGICAL: GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION

ENGINEERING DESCRIPTION: SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

GEOLOGICAL UNIT	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION
QUARTERNARY SANDS				AUGER						MH		V+				SILT, some fine sand, highly plastic, wet, brown. - becomes light brown orange, very stiff. - twigs.
										SM		L				SAND (fine to medium), some silt, loosely packed, wet, light brown orange brown.
									1							NO RECOVERY.
			450	SPT		4 4 5 N=9			2							
			1050	AUGER					3							
			450	SPT		3 5 5 N=10										
BOX 1			1050	AUGER					4							- becomes orange brown.
			450	SPT		4 4 5 N=10			5							
			1050	AUGER								MD				- black carbonaceous material. - becomes saturated.
									6							- black carbonaceous material.
			450	SPT		5 6 8 N=14										
			1050	AUGER					7	MH		St				SILT, some sand (fine), moderately plastic, firm to stiff, light grey.
												S				NO RECOVERY, recovered as silty mud as water filled in the bottom of the hole before run.
BOX 2			450	SPT		3 5 8 N=13				MH		St				SILT, clayey, soft to firm, grey brown, sticky as much water came out with sample, (water filling hole).
BOX 3									8							**END OF BOREHOLE AT 8.0m** - rods jammed. -piezometer installed to 9.0m. -screened.
									9							
									10							

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3
Hole Location: GPS mark 41

SHEET 1 OF 1

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 16/5/06
HOLE FINISHED: 16/5/06
DRILLED BY: LDE
LOGGED BY: SJWW CHECKED: JRL

GEOLOGICAL										ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL				AUGER							OL		St				SILT, some sand (fine), organic, roots, dark brown.
QUARTERNARY SANDS											SM						SAND (fine), very silty, non plastic, moist to wet, highly packed, grey brown.
									1		MH						SILT, slightly sandy, highly plastic, stiff to very stiff, wet, light brown mottled orange. - firm for 100mm.
			450	SPT		3 3 4 N=7			2				L				SAND (fine to medium), loosely packed, wet, occasional black specs, (carbonaceous material / or weathering), light orange brown.
			1050	AUGER					3								
			450	SPT		4 3 5 N=8											
BOX 1			1050	AUGER					4								
			450	SPT		4 5 7 N=12			5				M-D				
			2050	AUGER					6								- becomes saturated.
			450	SPT		5 9 12 N=21			7								
BOX 2			550	AUGER													- 50mm layer silty, very light grey / brown.
			450	SPT		9 10 9 N=19			8		MH						SILT, sandy (fine), saturated, soft to firm in some parts, SAND is dominant fraction (loosely packed), light brown.
			550	AUGER							SM		D				SAND, fine to medium, wet, only just tightly packed, orange brown mottled black.
BOX 3				SPT		20 for 75m bouncing so SPT stopped.			9								**END OF BOREHOLE AT 9.0m** - rods jammed. -piezometer installed. - 0.0 to 7.0m bentonite seal. - screened 7.0 to 9.0m.
									10								

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH4
Hole Location: GPS mark 42
SHEET 1 OF 1

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

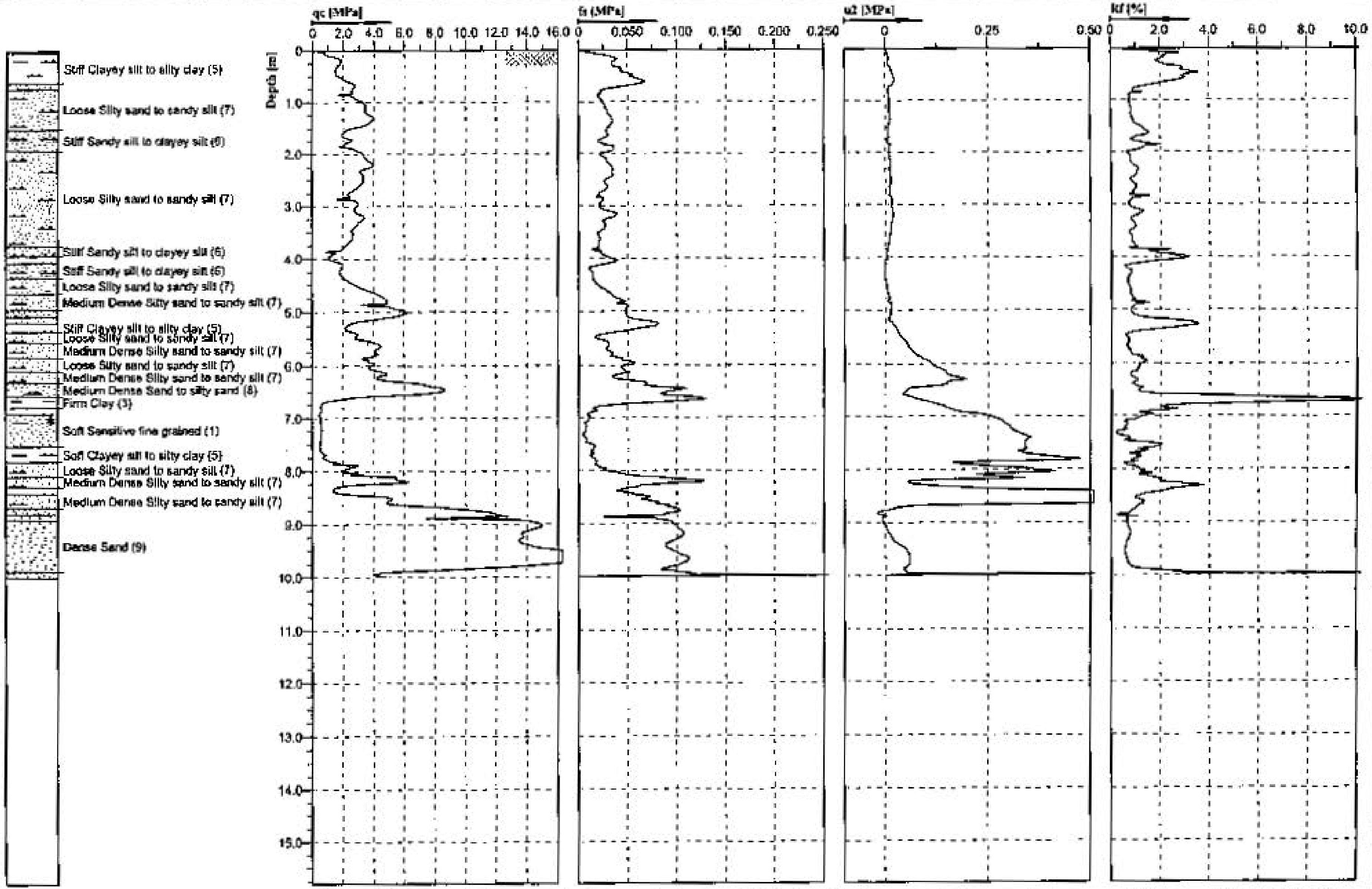
CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 16/5/06
HOLE FINISHED: 16/5/06
DRILLED BY: LDE
LOGGED BY: SJWW CHECKED: JRL

GEOLOGICAL GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	ENGINEERING DESCRIPTION SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL											OL		F				SILT, sandy, organic, roots, wet, dark brown.
ESTUARINE DEPOSITS				AUGER							MH						SILT, some sand, moderately plastic, wet, form, light brown mottled orange.
											SM						SAND (fine to medium), some silt, loosely packed, light orange brown.
									1		MH		St				SILT, sandy, stiff to very stiff, roots, low to moderately plastic, light brown grey. - becomes clayey, minor sand, very highly plastic, firm to stiff.
			450	SPT		0 1 1 N=2											
			1050	AUGER					2								
BOX 1									3								- becomes orange brown.
			450	SPT		0 2 3 N=5					SM		L				SAND (fine), crumbly, tightly packed, hard, moist, limonite, orange brown (dark orange).
			1050	AUGER							SM						SAND (fine to medium), loosely packed to tightly packed orange brown with black fine gravel sized specks.
									4		MH						SILT, minor fine sand, wet, stiff, highly plastic, orange brown.
											MH						SILT, hard orange brown with very hard SAND to coarse gravel sized angular orange brown clasts of limonite.
			450	SPT		2 3 6 N=9			5		MH						SILT, clayey, minor fine to coarse rounded sand, (sand green grey and white), very highly plastic, stiff to very stiff, light grey. - coarse gravel very rounded (one).
			1050	AUGER							SM		MD				SAND (fine), silty with some medium to coarse SAND tightly packed. - coarse gravel sized light green grey SILT clast.
BOX 2			75	SPT		12 30 20 N=50 for 75mm			6				D				- 6.0 to 6.5m orange brown to brown stained layers up to 10mm thick.
BOX 3			925	AUGER													- saturated.
			50	SPT		20 for 50mm bouncing			7								**END OF BOREHOLE 4 AT 7.0m** - rods jammed.
									8								
									9								
									10								

Appendix C: CPT Logs



DE DEVELOPMENT & EXPLORATION LTD

u2

Cone No: 6
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT1
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
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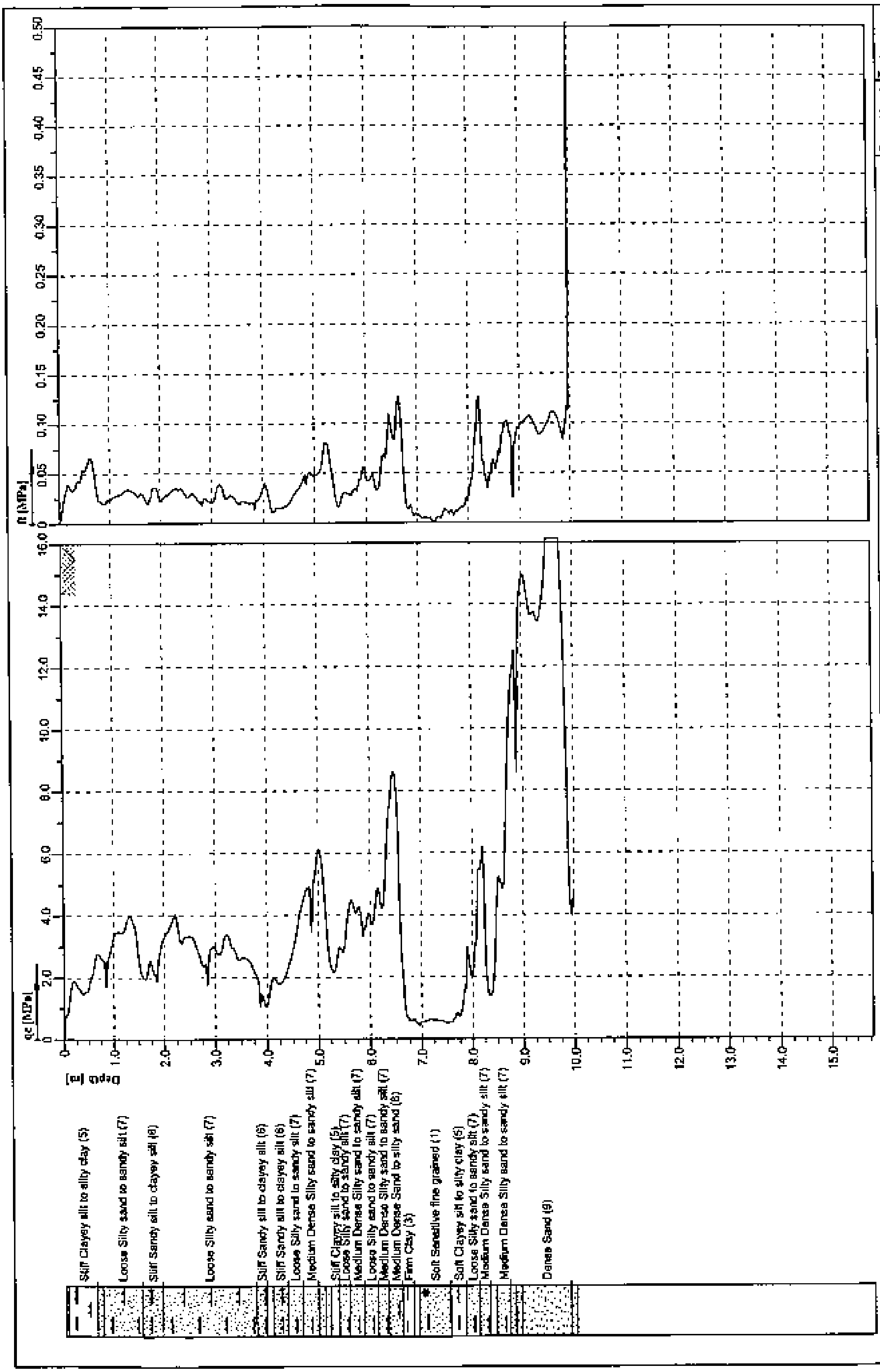

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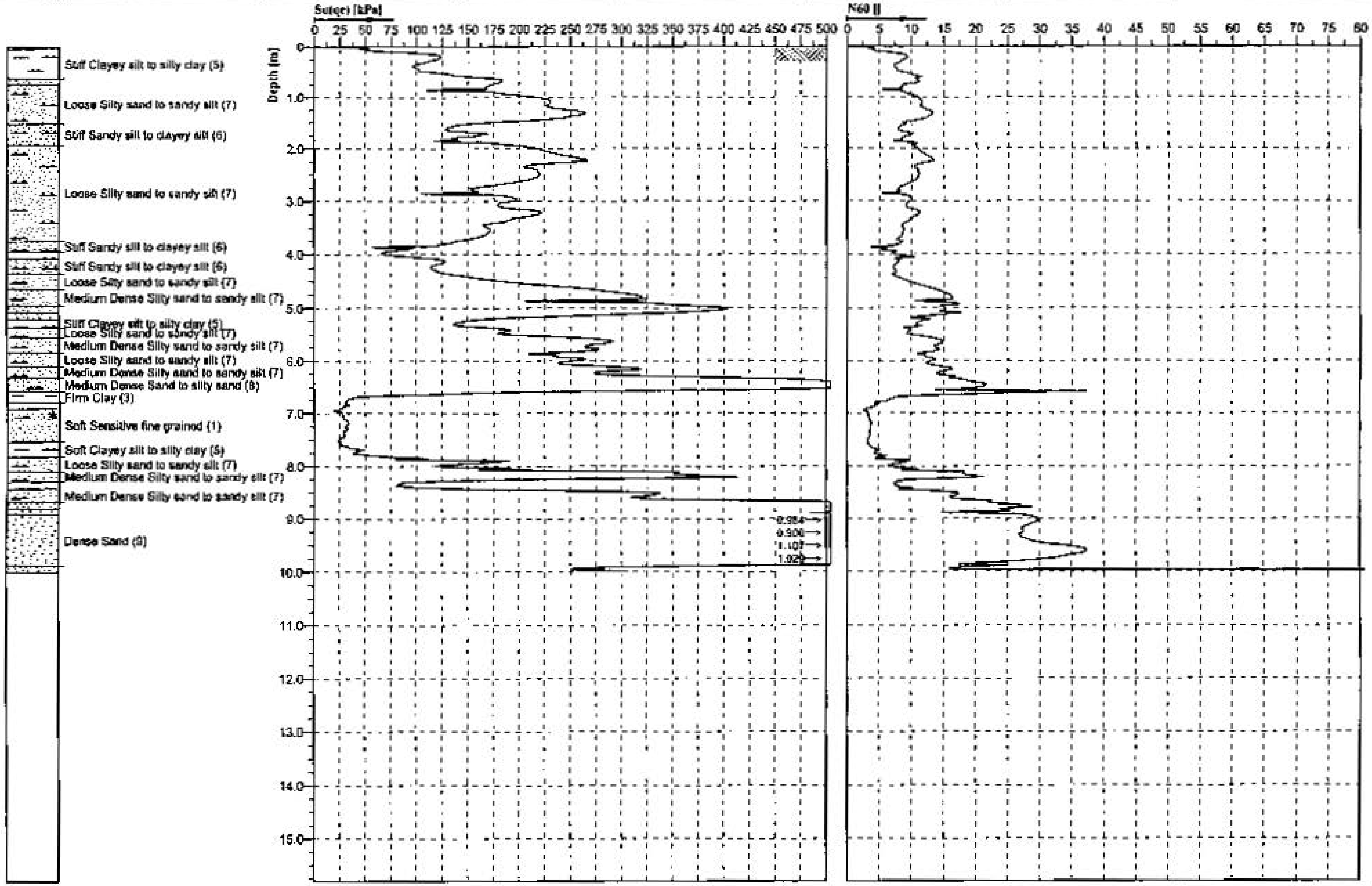
Date: 17/05/2006	Scale: 1 : 100
Page: 1/1	Fig:
File: cpt10.001	

Location: MANGAWHAI HEADS
Position: X: 0.00 m, Y: 0.00 m
Project ID: D1131
Client: TONKIN & TAYLOR LTD
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150



u2

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS
Position: X: 0.00 m, Y: 0.00 m
Ground level: 0.00
Test no: CPT1
Project ID: D1131
Client: TONKIN & TAYLOR LTD
Date: 17/05/2006
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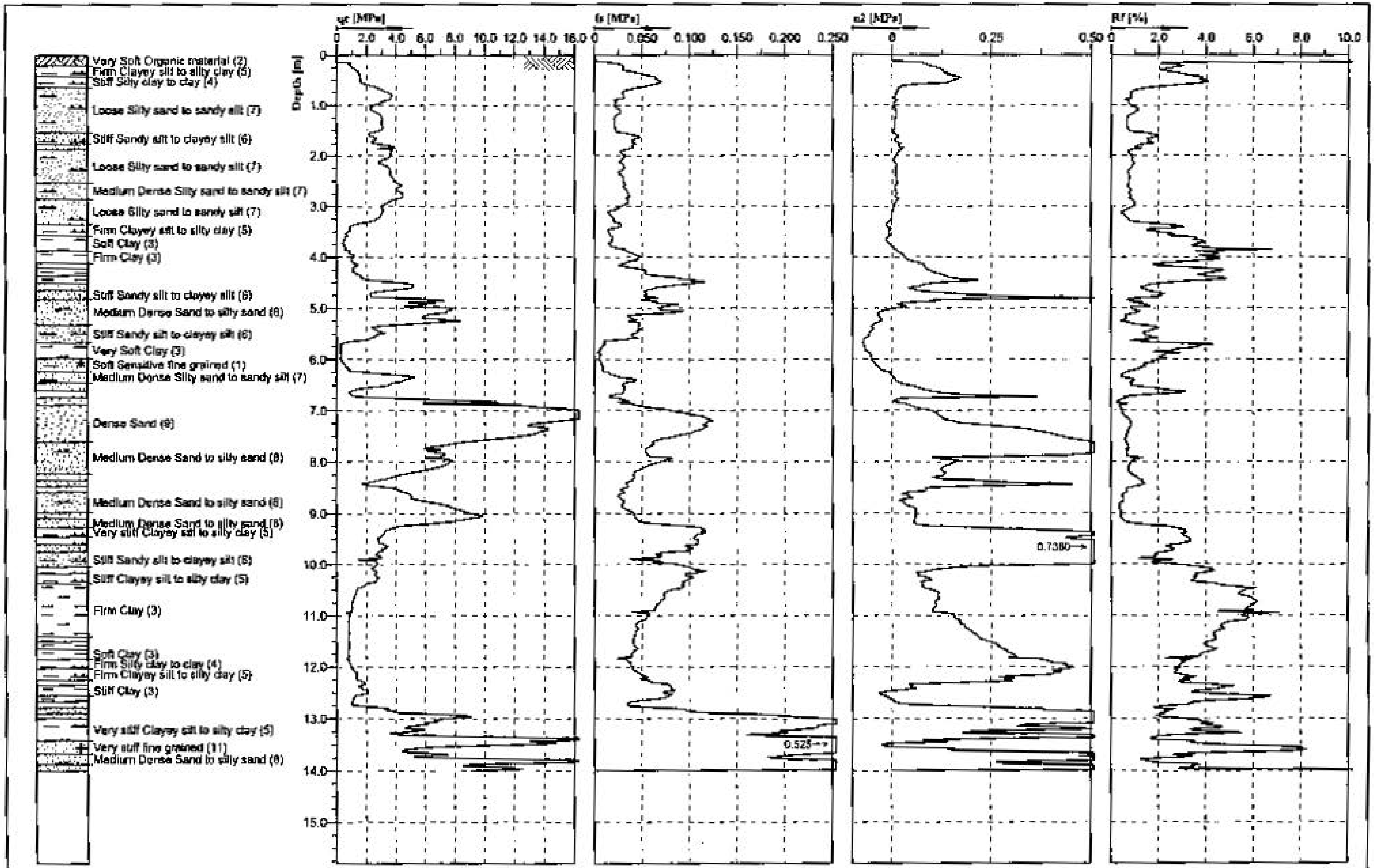

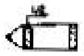

Cone No: 0
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Sleeve area [cm2]: 150

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Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
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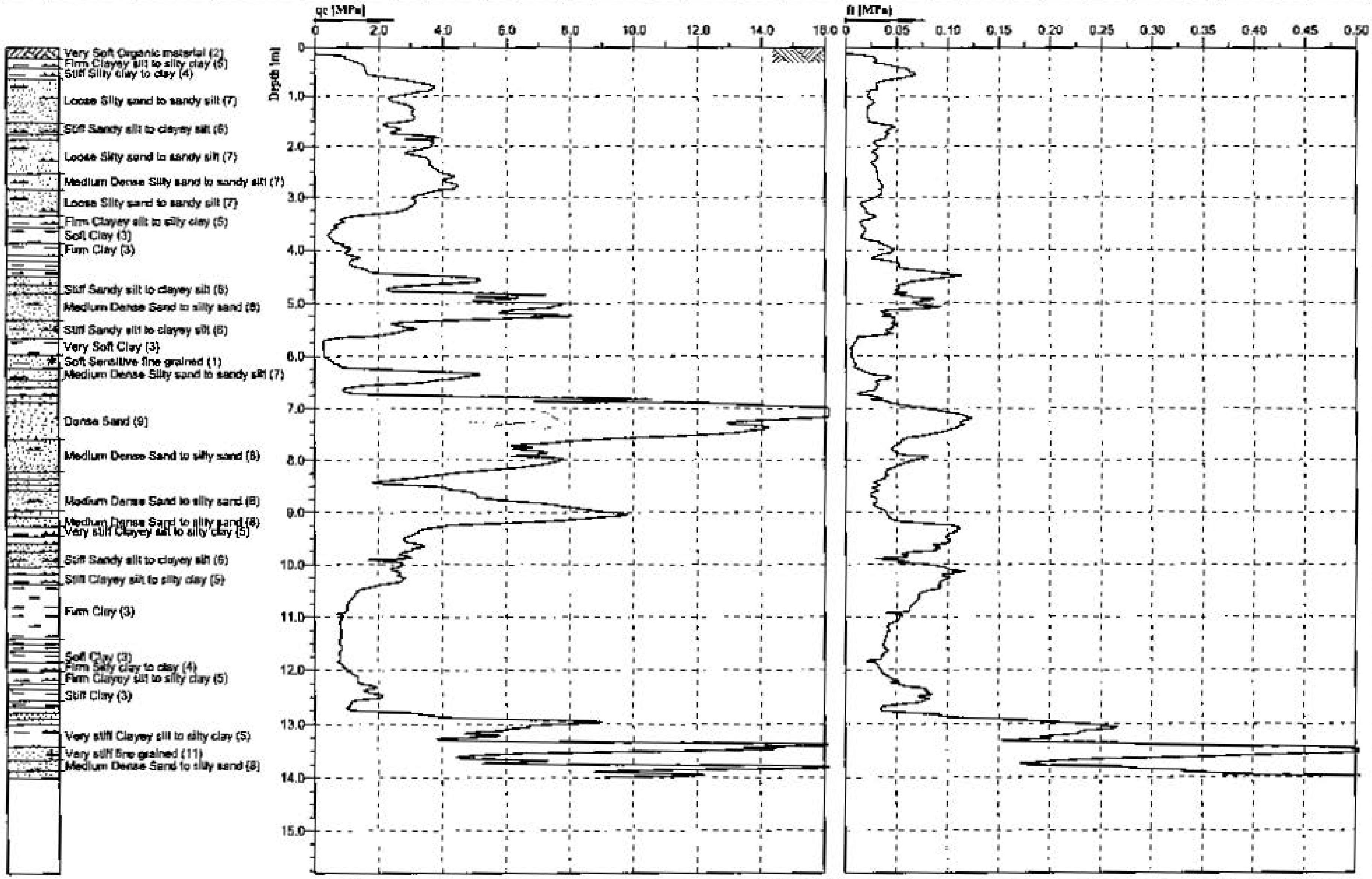

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT2
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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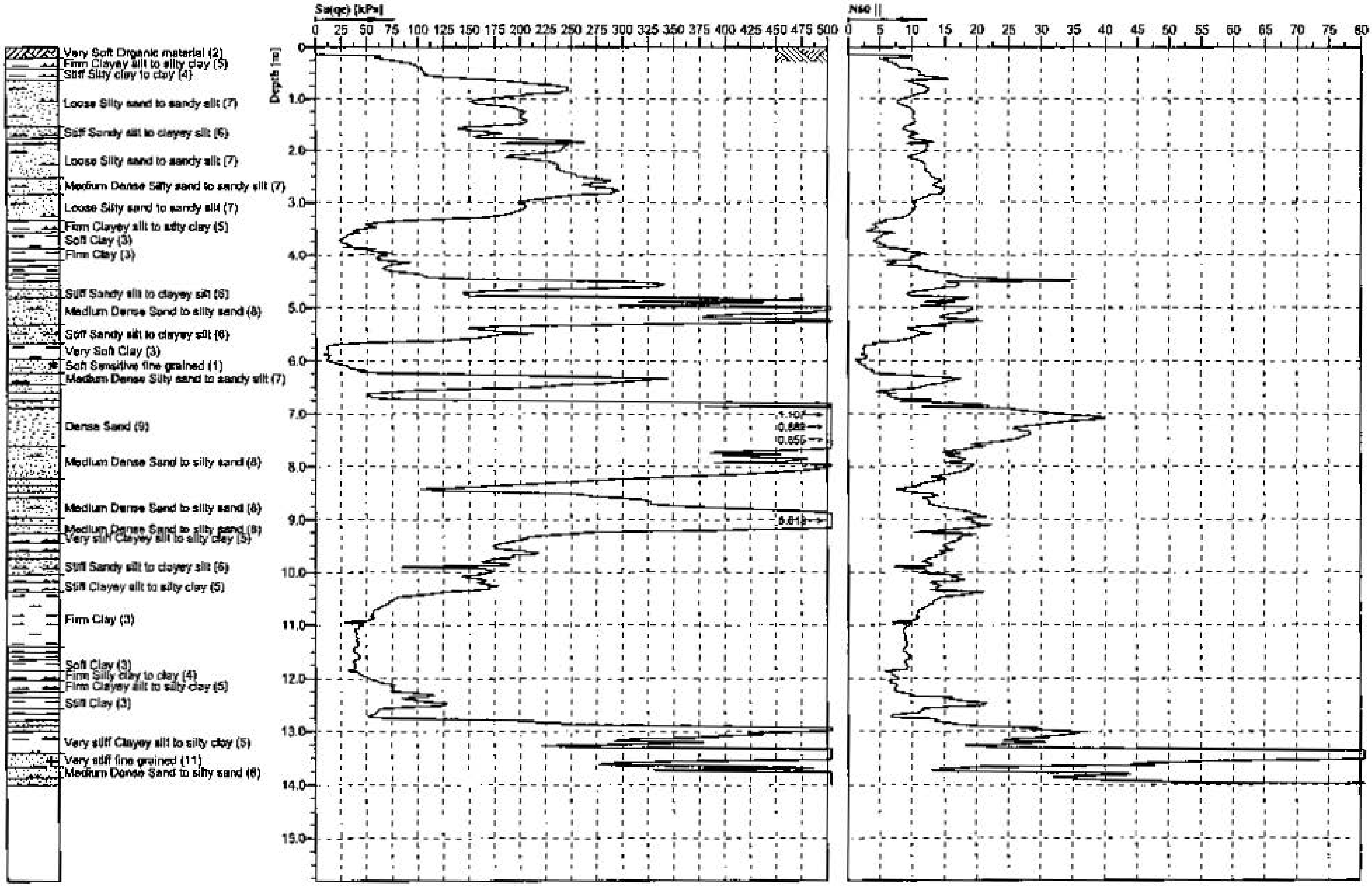
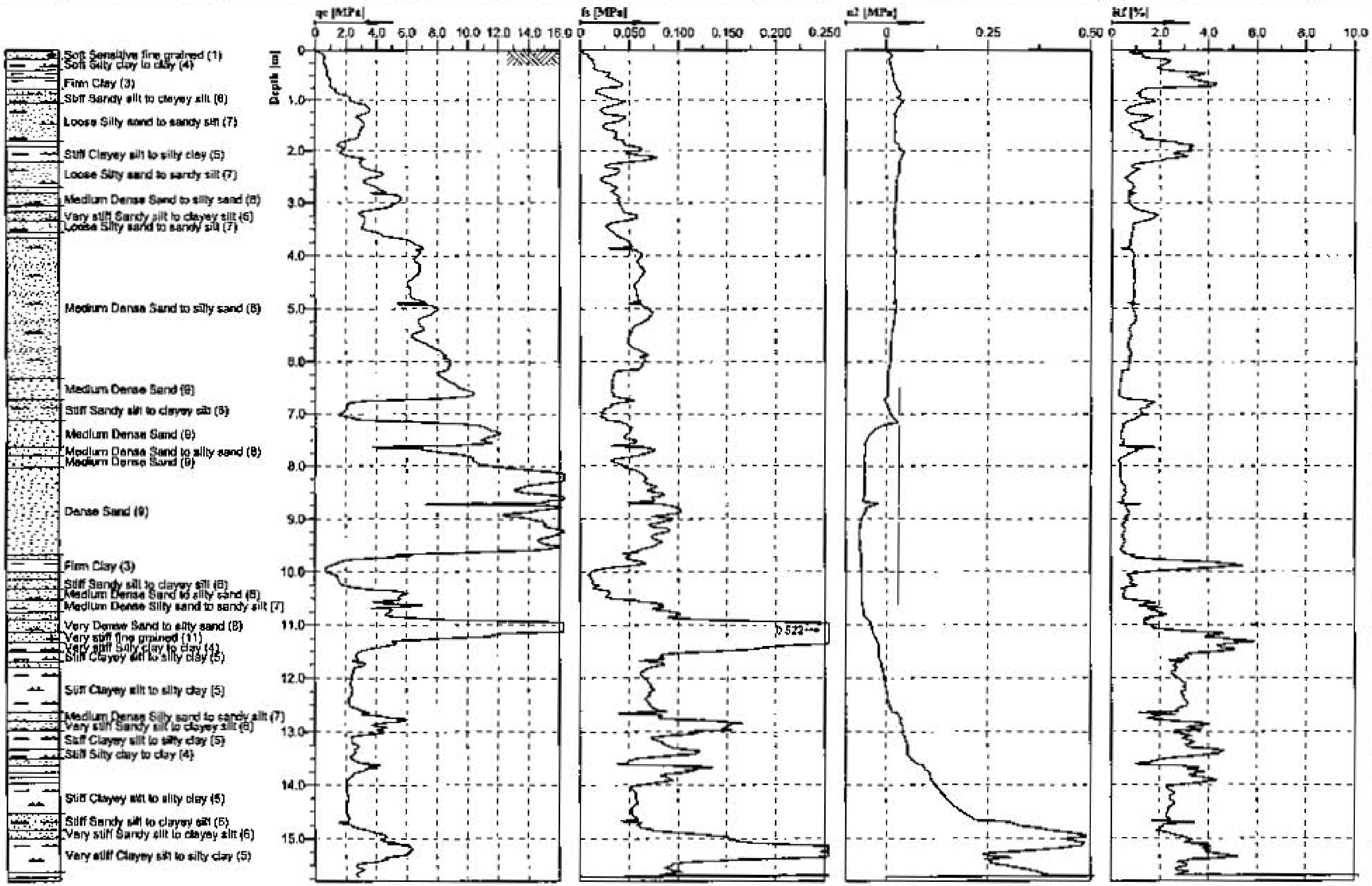


DE DEVELOPMENT TEST & EXPLORATION

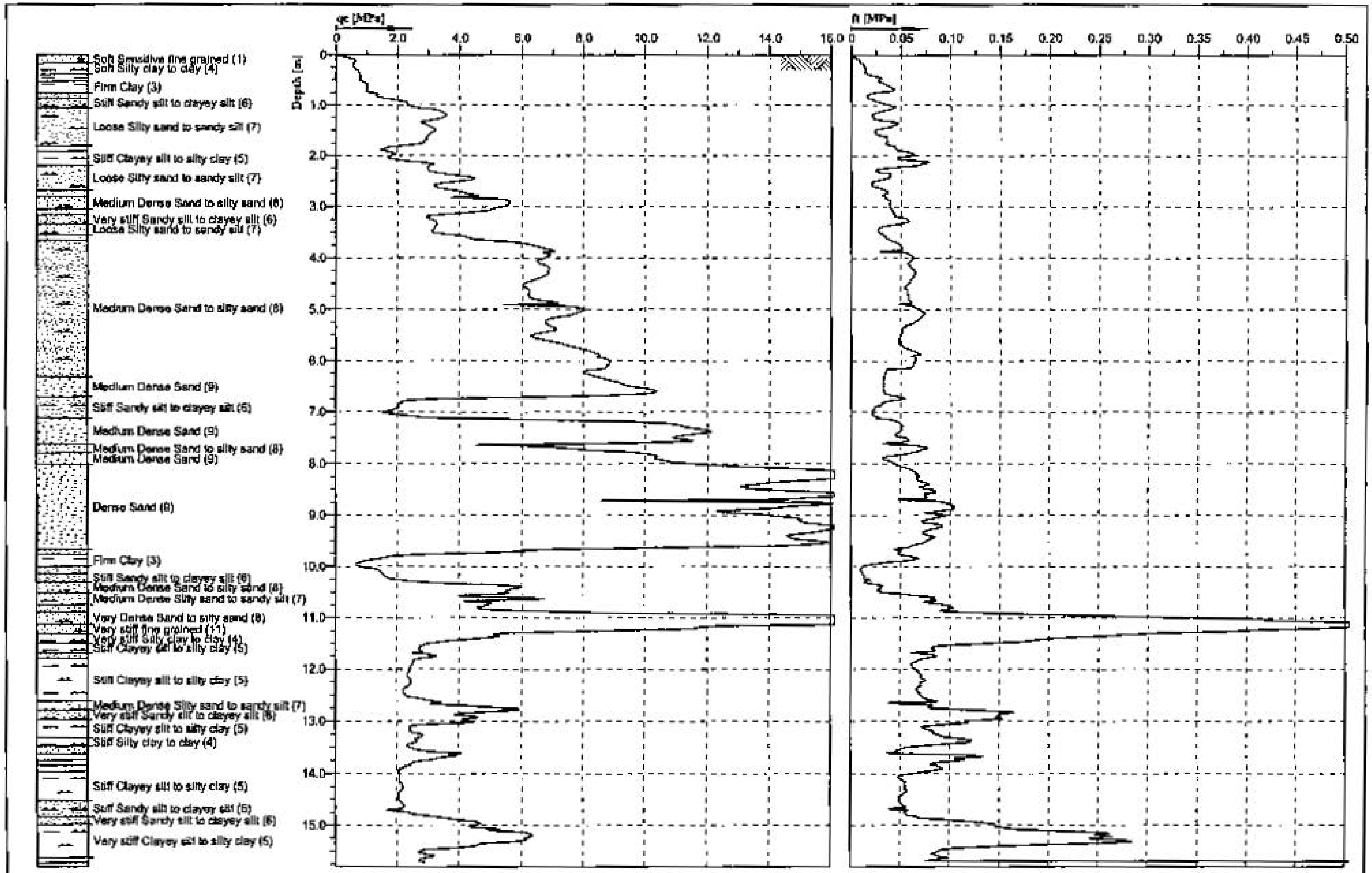
Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT2
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt2.001	



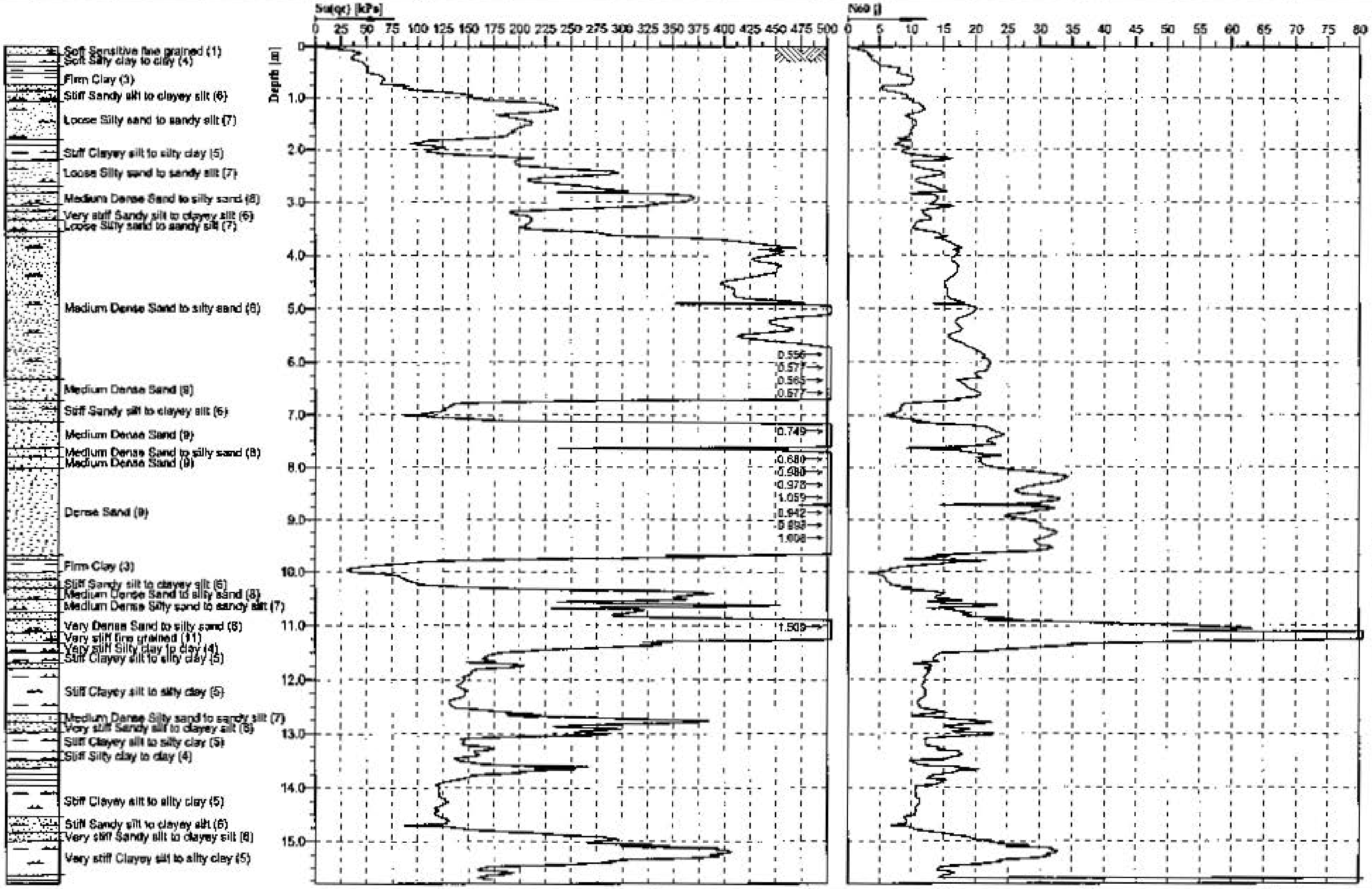
Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT3
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt3.001	



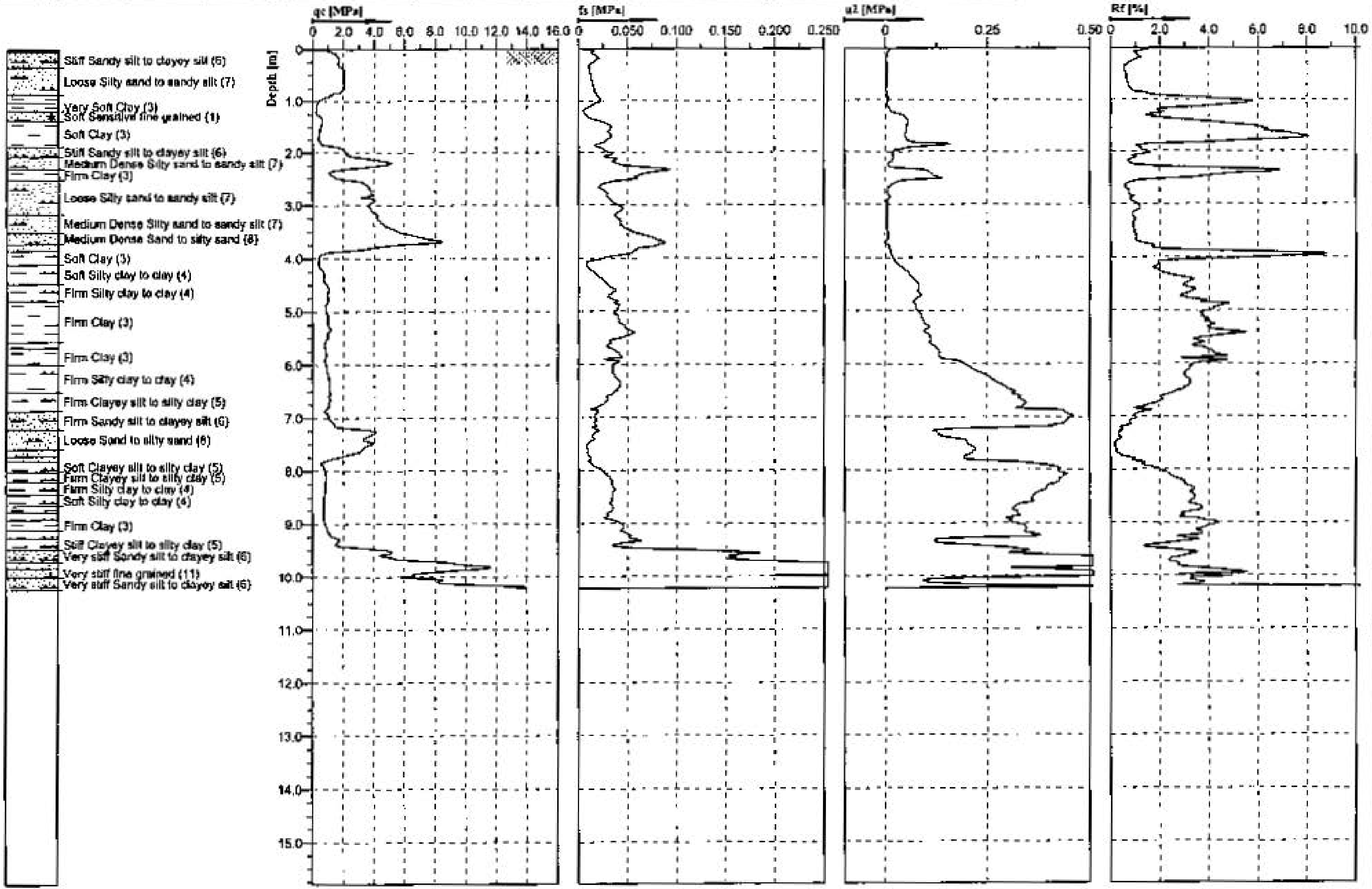
Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT3
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt3.001	



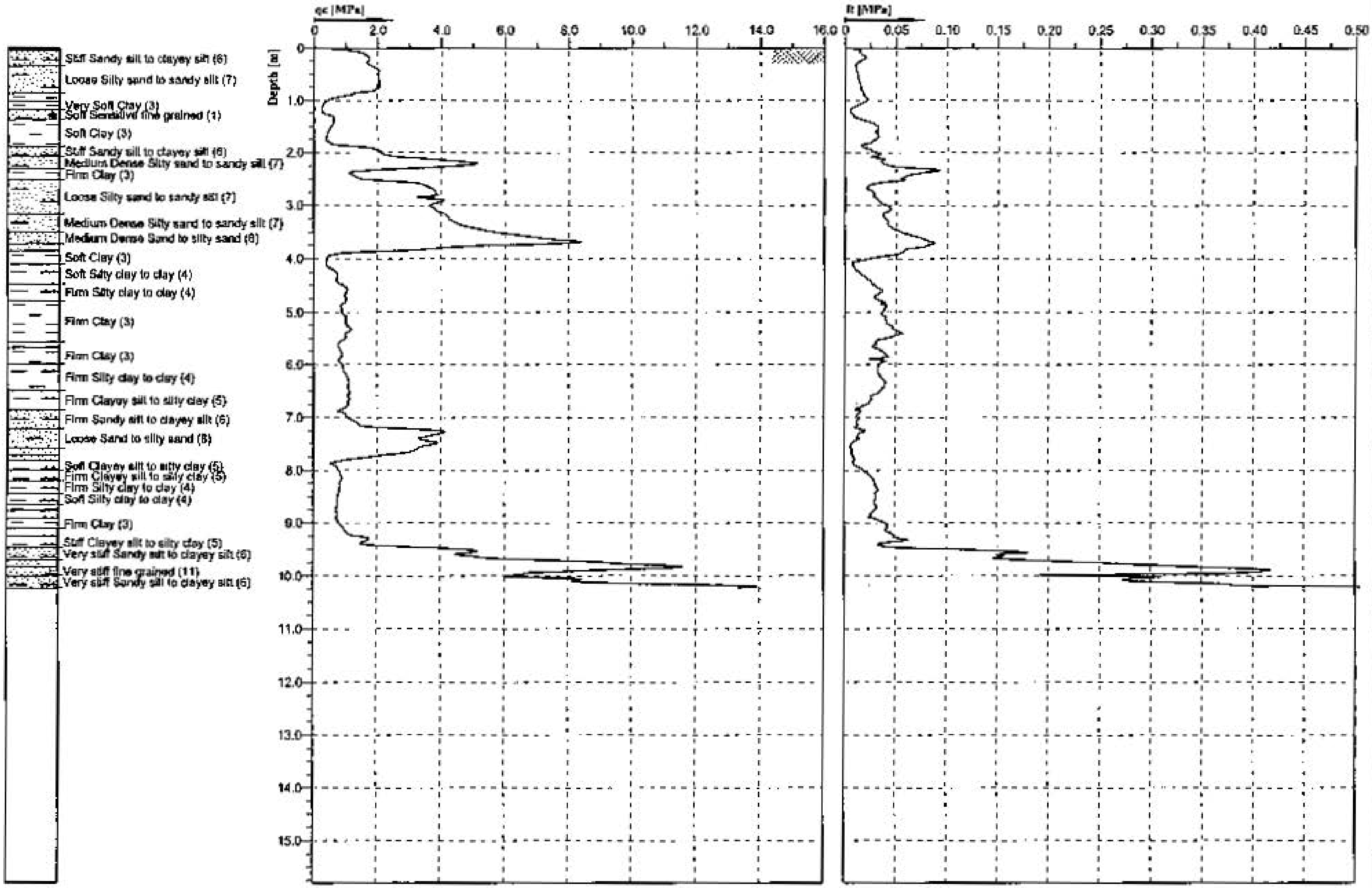
Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS		Position: X: 0.00 m, Y: 0.00 m		Ground level: 0.00	Test no: CPT3
Project ID: D1131		Client: TONKIN & TAYLOR LTD		Date: 17/05/2005	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001				Page: 1/1	Fig:
				File: cpt3.001	



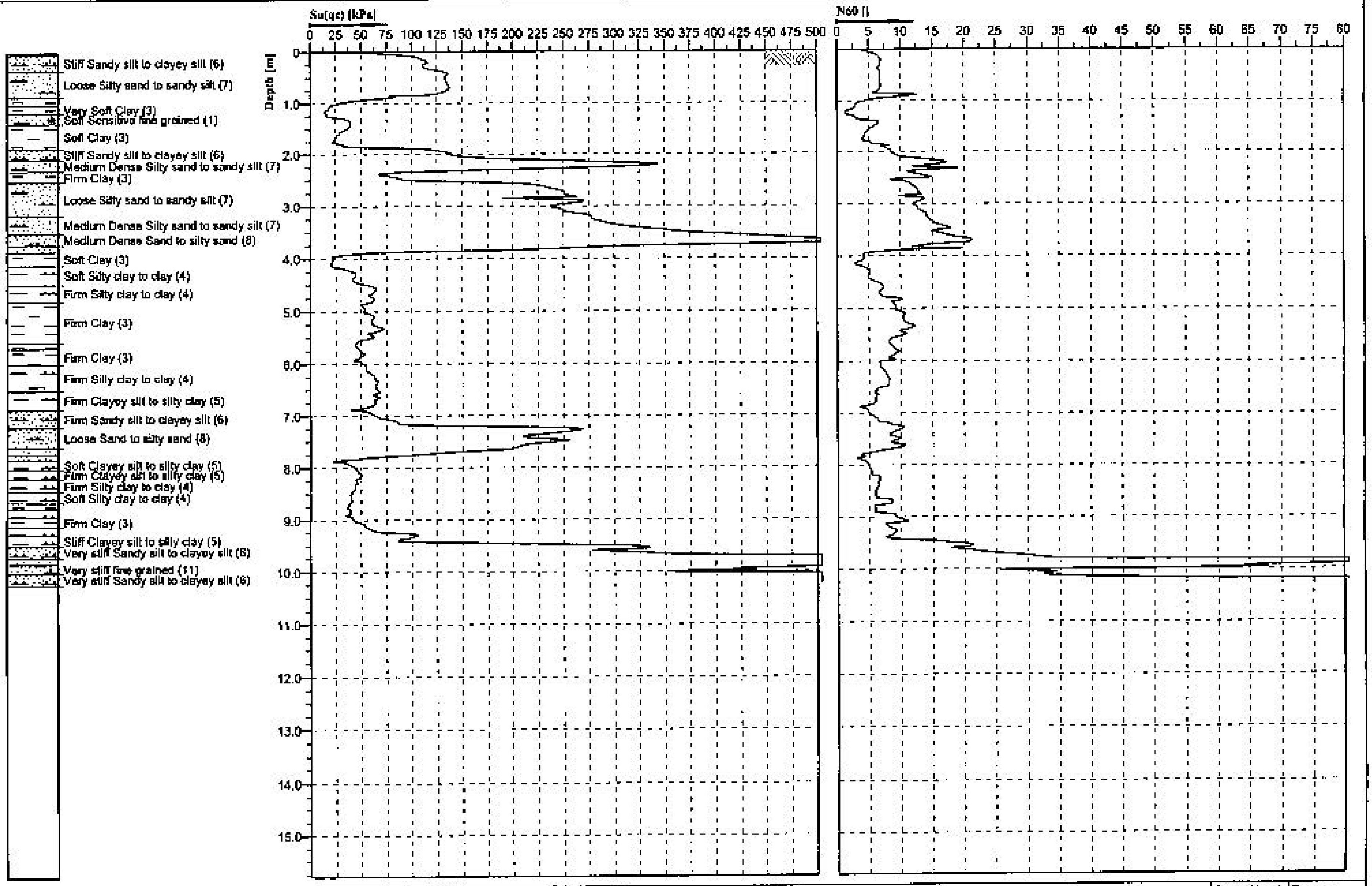
Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location:	MANGAWHAI HEADS	Position:	X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT4
Project ID:	D1131	Client:	TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project:	MANGAWHAI HEADS SEWER PLANT - 23428.001			Page: 1/1	Fig:
				File: cpt15.001	

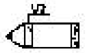


Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS
Position: X: 0.00 m, Y: 0.00 m
Ground level: 0.00
Test no: CPT4
Project ID: D1131
Client: TONKIN & TAYLOR LTD
Date: 17/05/2008
Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001
Page: 1/1
Fig:
File: cpt15.001

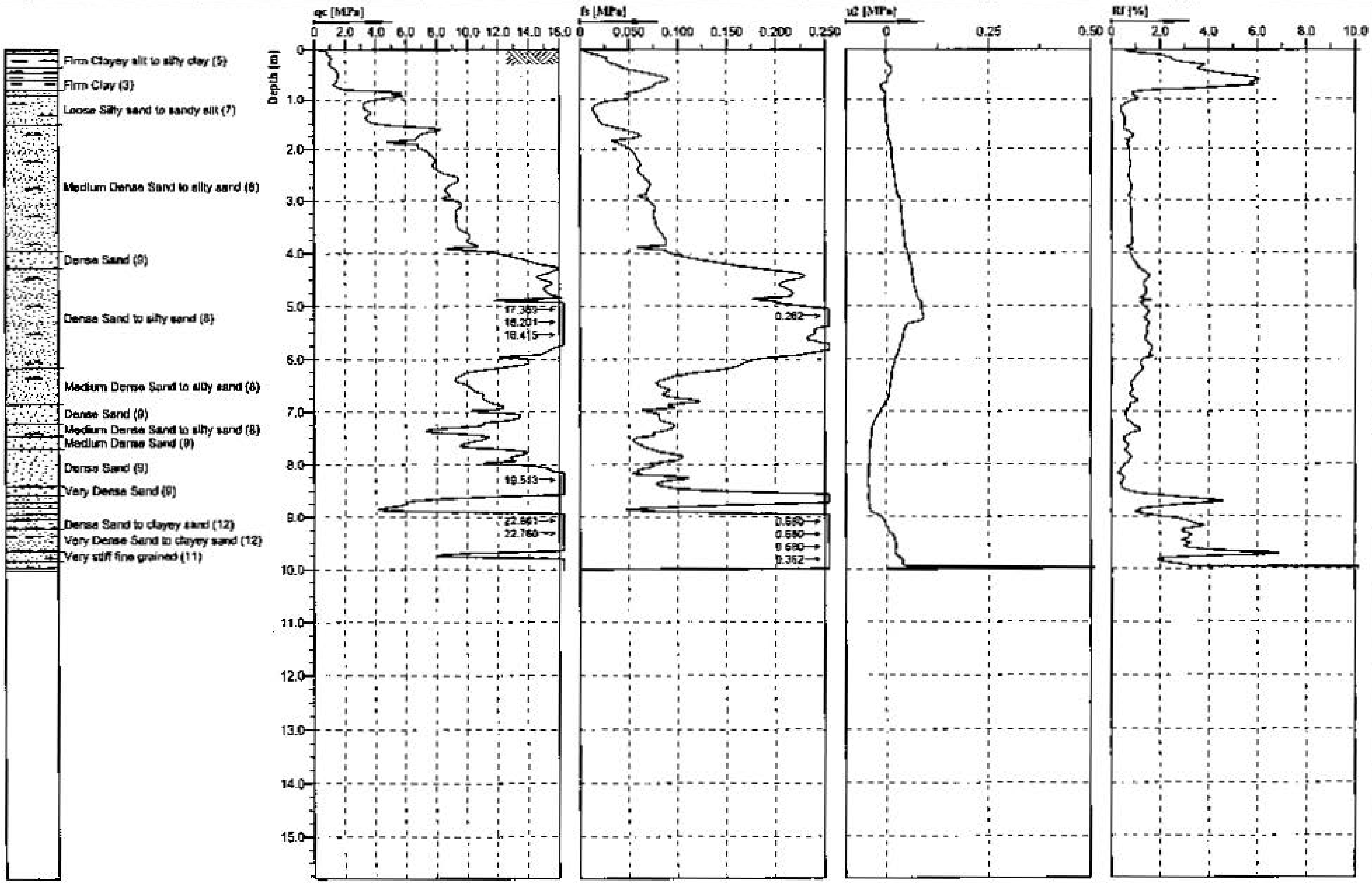


DEVELOPMENT & EXPLORATION LTD.



Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

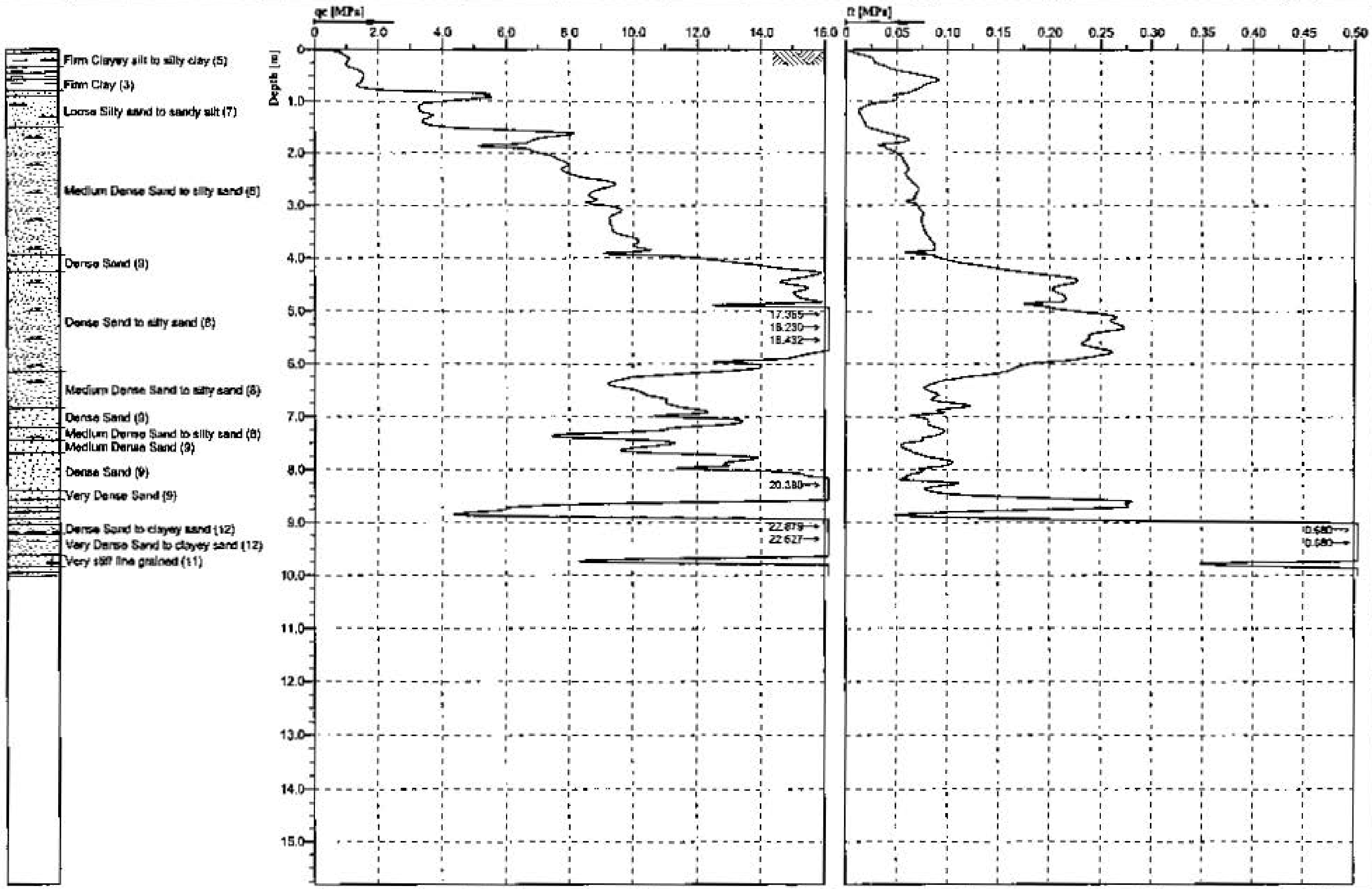
Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT4
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt15.001	



u2

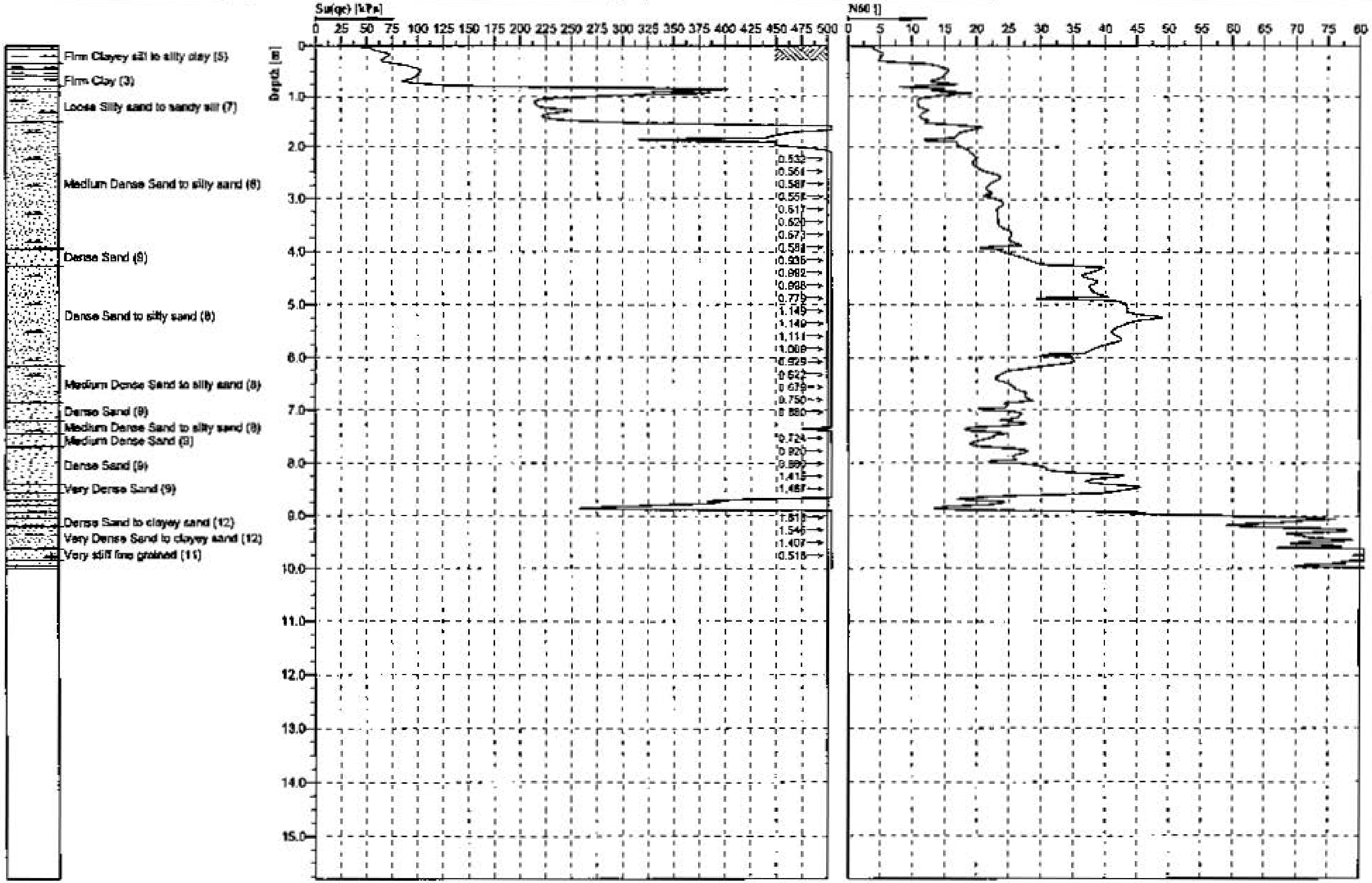
Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT5
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: CPT5.002	



Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

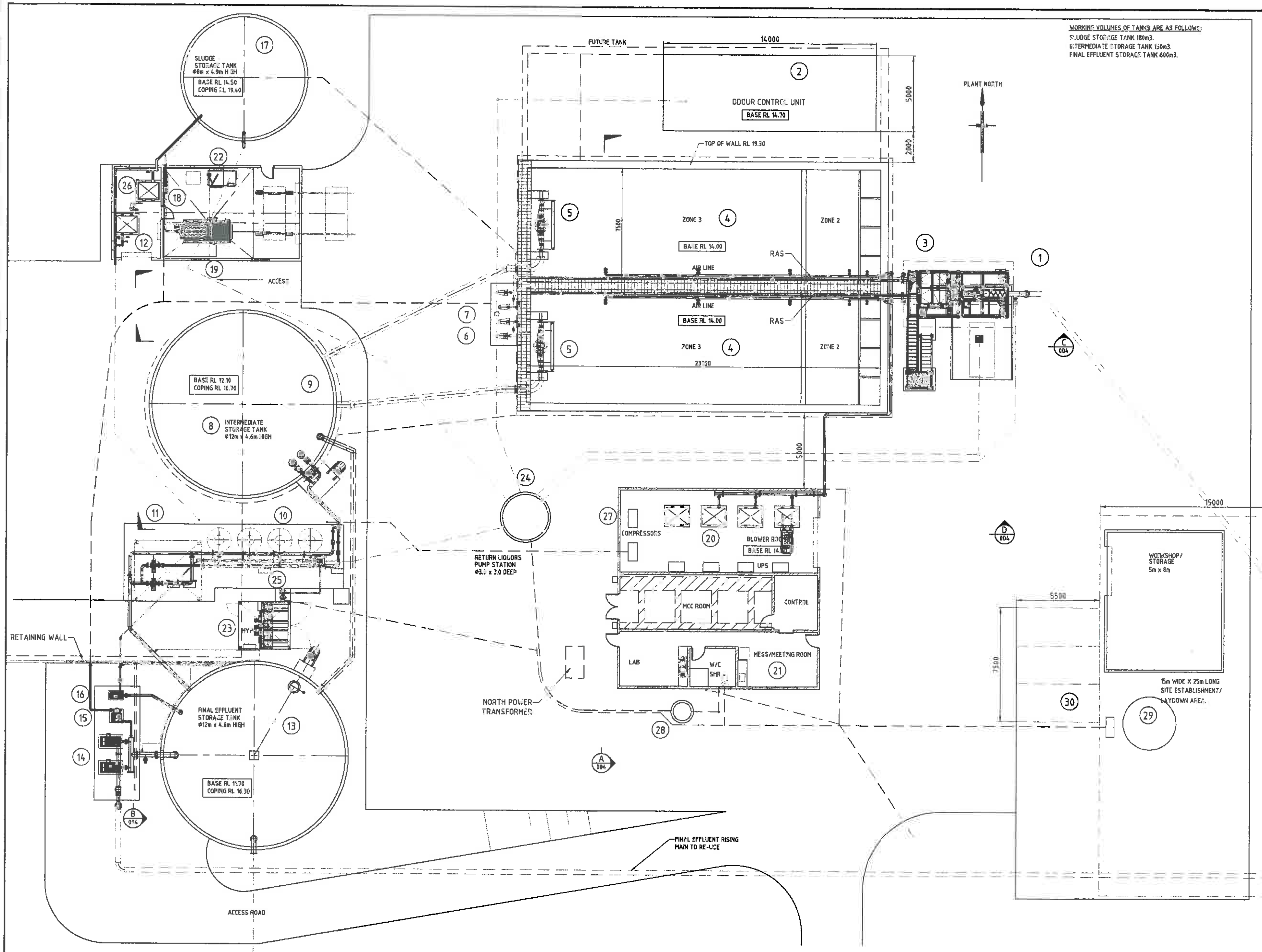
Location:	MANGAWHAI HEADS	Position:	X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT5
Project ID:	D1131	Client:	TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project:	MANGAWHAI HEADS SEWER PLANT - 23428.001			Page: 1/1	Fig:
				File: CPT5.002	



DEVELOPMENT & EXPLORATION LTD.

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS		Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT5
Project ID: D1131		Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001			Page: 1/1	Fig:
			File: CPT5.002	



WORKING VOLUMES OF TANKS ARE AS FOLLOWS:

SLUDGE STORAGE TANK 180m3.
INTERMEDIATE STORAGE TANK 150m3.
FINAL EFFLUENT STORAGE TANK 600m3.

LEGEND

- ① INLET WORKS
- ② ODOUR CONTROL BIOBED
- ③ FLOW SPLITTER
- ④ CASS TANKS 1 & 2 WITH AERATION SYSTEM
- ⑤ CASS DECANTER
- ⑥ RAS PUMPS
- ⑦ WAS PUMPS
- ⑧ INTERMEDIATE STORAGE TANK
- ⑨ TRANSFER PUMPS
- ⑩ MULTIMEDIA FILTERS
- ⑪ ULTRAVIOLET DISINFECTION
- ⑫ AIR SCOUR BLOWER
- ⑬ FINAL EFFLUENT STORAGE TANK
- ⑭ IRRIGATION TRANSFER PUMPS
- ⑮ BACKWASH PUMPS
- ⑯ SERVICE WATER PUMPS
- ⑰ SLUDGE TANK
- ⑱ SLUDGE TRANSFER PUMPS
- ⑲ FILTER BELT PRESS & GRAVITY DECK
- ⑳ AERATION BLOWERS
- ㉑ ADMIN/CONTROL BUILDING
- ㉒ POLYMER SYSTEM PACKAGE
- ㉓ SODIUM HYPOCHLORITE SYSTEM
- ㉔ RETURN LIQUORS PUMP STATION
- ㉕ EMERGENCY SHOWER & EYEWASH
- ㉖ SLUDGE BLOWERS
- ㉗ COMPRESSORS
- ㉘ GRINDER PUMP
- ㉙ POTABLE WATER TANK
- ㉚ CAR PARKING SPACES

REV	DESCRIPTION	DRN	DATE	CHK	APP
J	DRAIN MODIFICATIONS	DIJ	13.1.09	CJ	RJ
H	GENERAL REVISIONS	DIJ	9.1.09	CJ	RJ
G	REVISED	DIJ	22.9.08	CJ	RJ
F	REVISED	DIJ	9.9.08	CJ	
E	REVISED SITE ARRANGEMENT	DIJ	3.9.08	C.J.	C.J.
D	INLET WORKS UPDATED	DIJ	5.8.08	AC	IF
C	GENERAL MODIFICATIONS	DIJ	10.7.08	AC	IF
B	CASS TANKS UPSIZED. CONTROL BUILDING ALTERED	DIJ	16.4.08	AC	IF
AC	AS CONSTRUCTED	DIJ	7.7.09	RJ	CJ

AS CONSTRUCTED
Information supplied by construction contractor

mangawhai ecocare
Maintaining Our Environment

0 2.5m 5m
Scale 1:125

EARTH TECH
Global Water Projects and Products
Melbourne - Tel 8517 9200

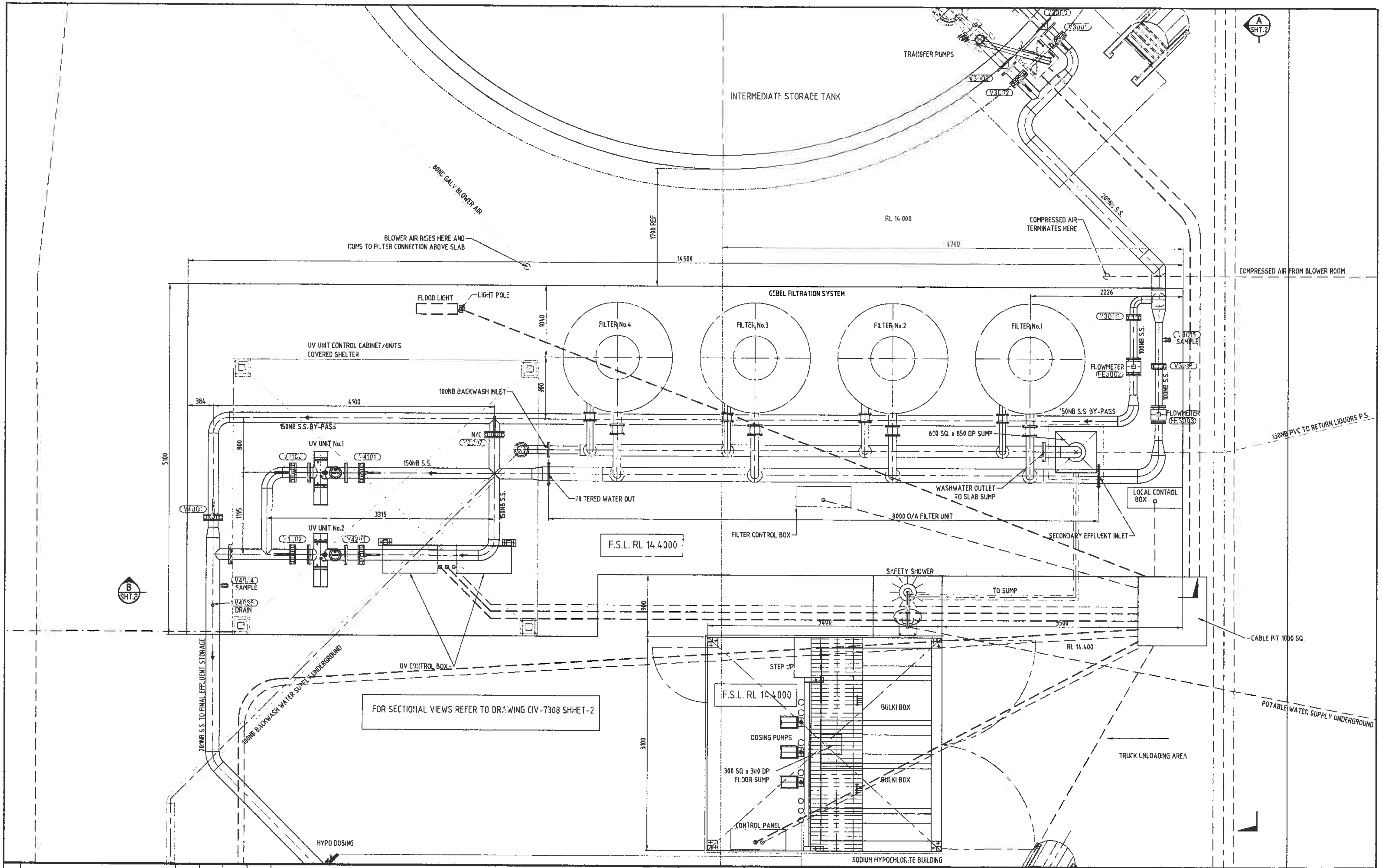
Designed	A.CHAPLIN
Drawn	D.JOULES
Checked	A.CHAPLIN
Approved	I.FONES

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

TREATMENT PLANT
GENERAL ARRANGEMENT

Drawing No. A-89973-CIV-7303 Rev AC
Sheet No. 89973

A1



REV	DESCRIPTION	DRN	DATE	CHK	APP
AC	AS CONSTRUCTED	DU	8.7.09	RJ	CJ

AS CONSTRUCTED
Information supplied by construction contractor

mangawhai ecocare
Maintaining Our Environment

0 0.5m 1.0m
Scale 1:25

EARTH TECH
Water Infrastructure Group
Melbourne - Tel 98633500

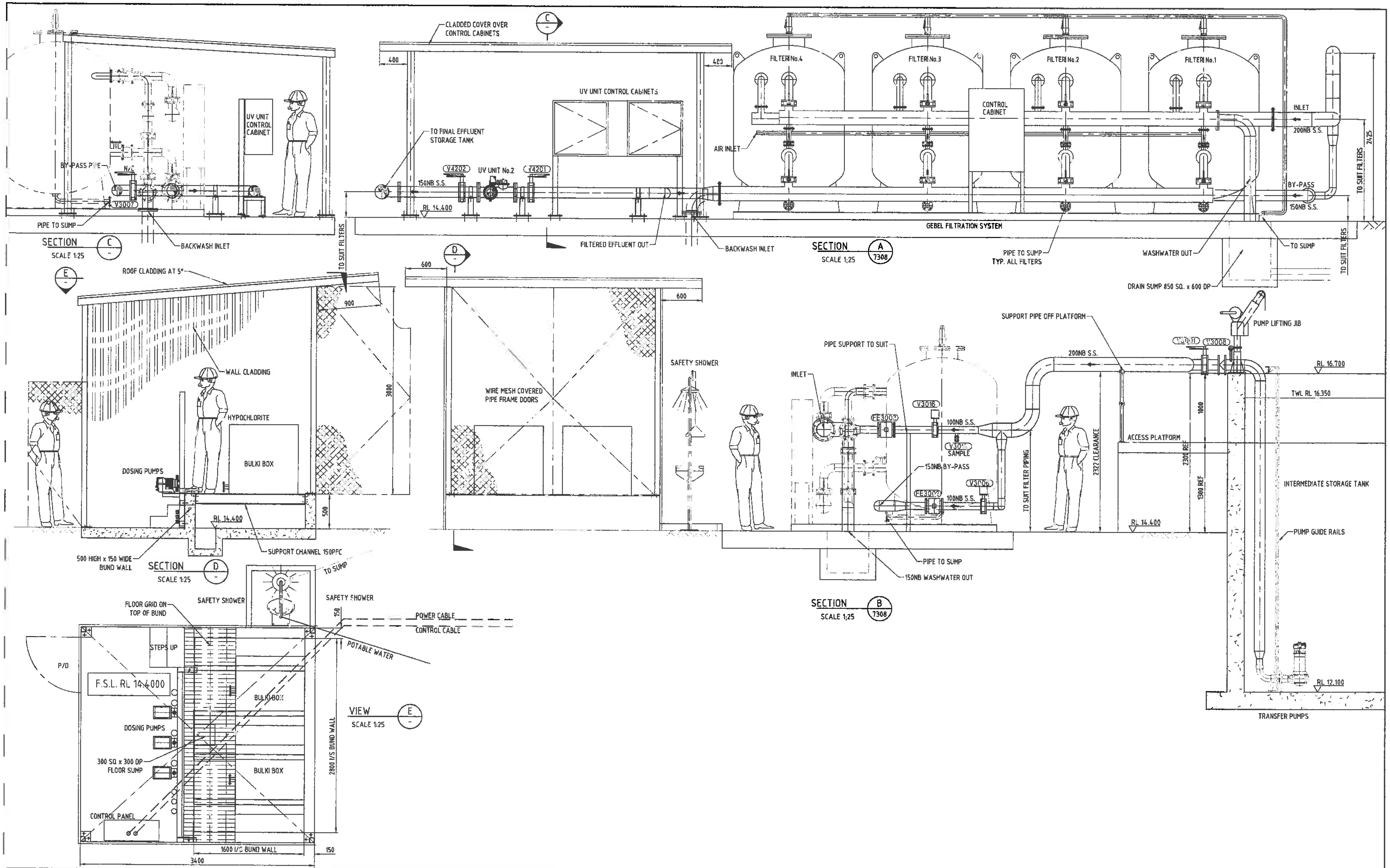
Designed R.JOHNSON
Drawn D.JOULES
Checked C.JOHNSTON
Approved X

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

ULTRAVIOLET DISINFECTION & SODIUM HYPOCHLORITE ARRANGEMENT-SHEET-1

Drawing No. A1-89973-CIV-7308 Rev AC
Sheet No. SHEET 1 89973

A1



REV	DESCRIPTION	DRN	DATE	CHK	APP
0	ISSUED FOR CONSTRUCTION	DIJ	24.4.09	RJ	CJ
C	COVER OVER UV AND DRAINAGE SUMP ALTERED	DIJ	26.3.09	RJ	CJ
B	HYPO BUILDING ALTERED	DIJ	20.2.09	CJ	RJ
A	ISSUED FOR APPROVAL	DIJ	18.2.09	CJ	RJ

ISSUED FOR CONSTRUCTION

mangawhai ecocare
Maintaining Our Environment

0 0 0.5m 1.0m
Scale 1:25

EARTH TECH
Water Infrastructure Group
Melbourne - Tel 98633500

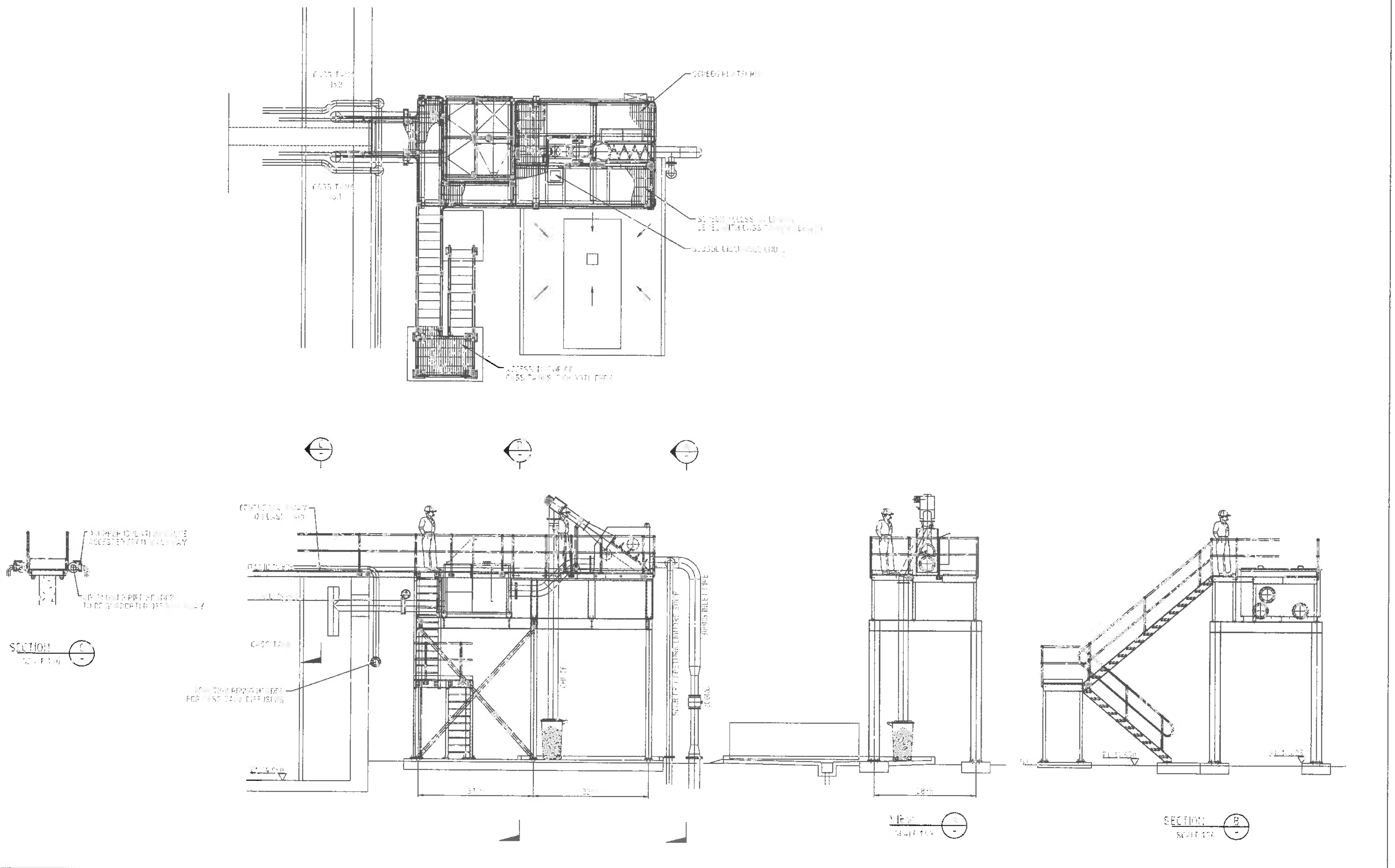
Designed R.JOHNSON
Drawn D.JOULES
Checked C.JOHNSTON
Approved X

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

ULTRAVIOLET DISINFECTION & SODIUM
HYPOCHLORITE SECTIONS SHEET-2

Drawing No. A-89973-CIV-7308 Rev 0
Sheet No. SHEET 2 89973

A1



AS BUILT

REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

0 1.0m 2.0m

Scale 1:50

Water Infrastructure Group

A Tyco International Company

MANGAWHAI ECOCARE

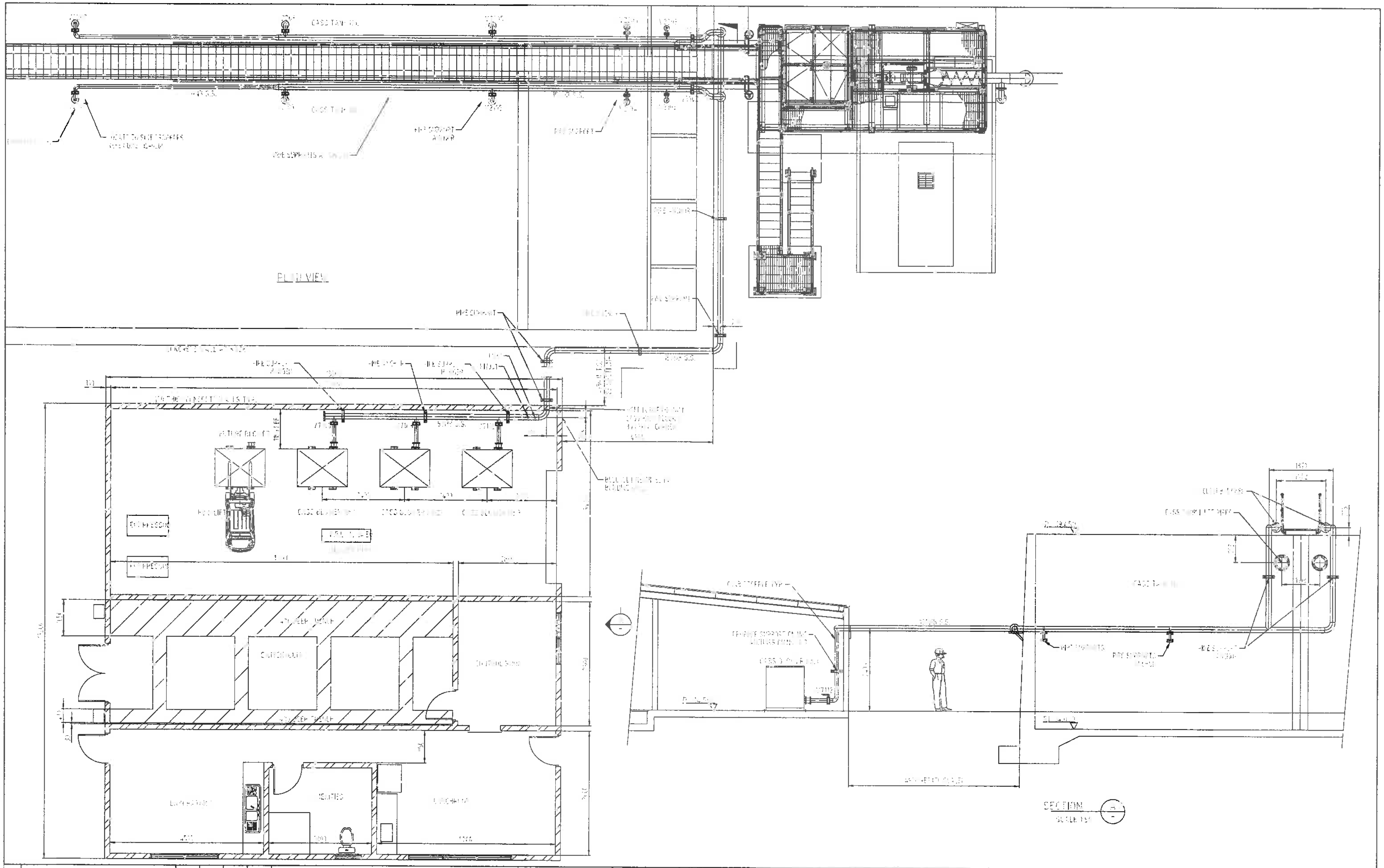
MANGAWHAI INFRASTRUCTURE PROJECT

INLET WORKS
PRELIMINARY LAYOUT

Drawing No. A-89973-CIV-7309 Rev 0

Sheet No. 89973

A1



REV	DESCRIPTION	DRN	DATE	CHK	APP
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AS BUILT

0 1.0m 2.0m

Scale 1:50

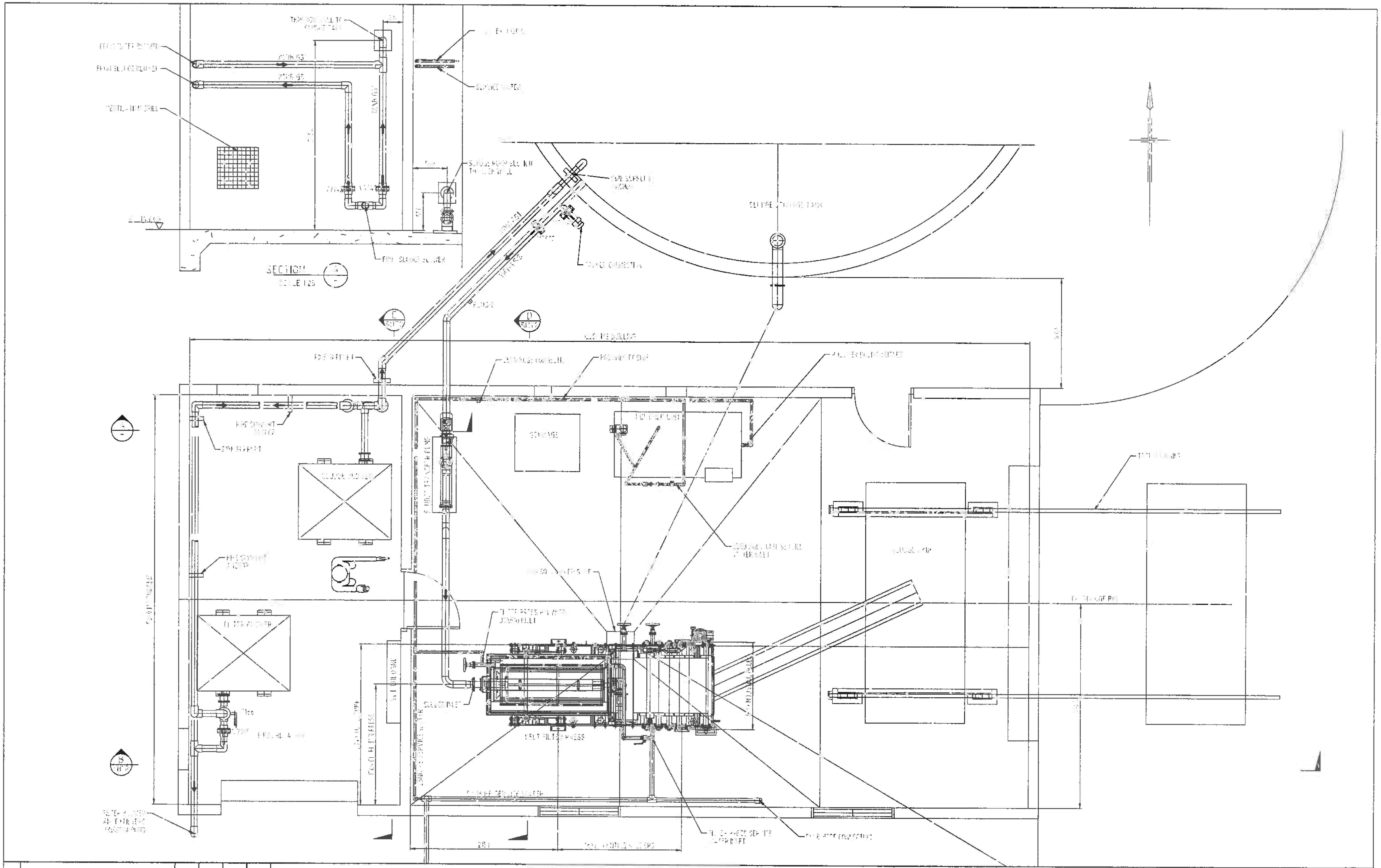
Water Infrastructure GROUP
A Tyco International Company

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

MAIN BUILDING
EQUIPMENT & PIPING ARRANGEMENT

Drawing No. A-89973-CIV-7311 Rev 0
Sheet No. 89973

A1



REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

0 0.5m 1m

Scale 1:25

Water Infrastructure GROUP
A Tyco International Company

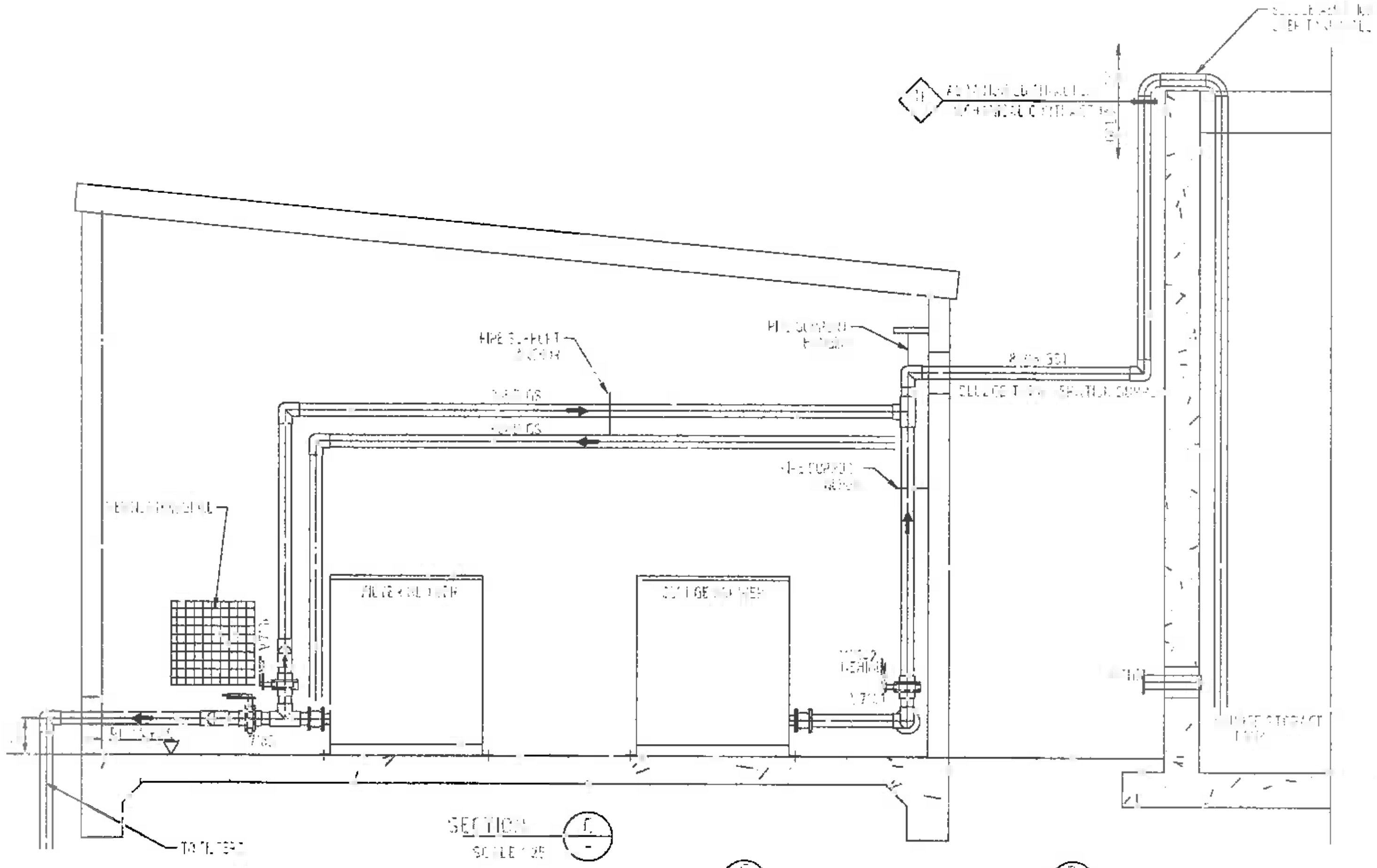
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

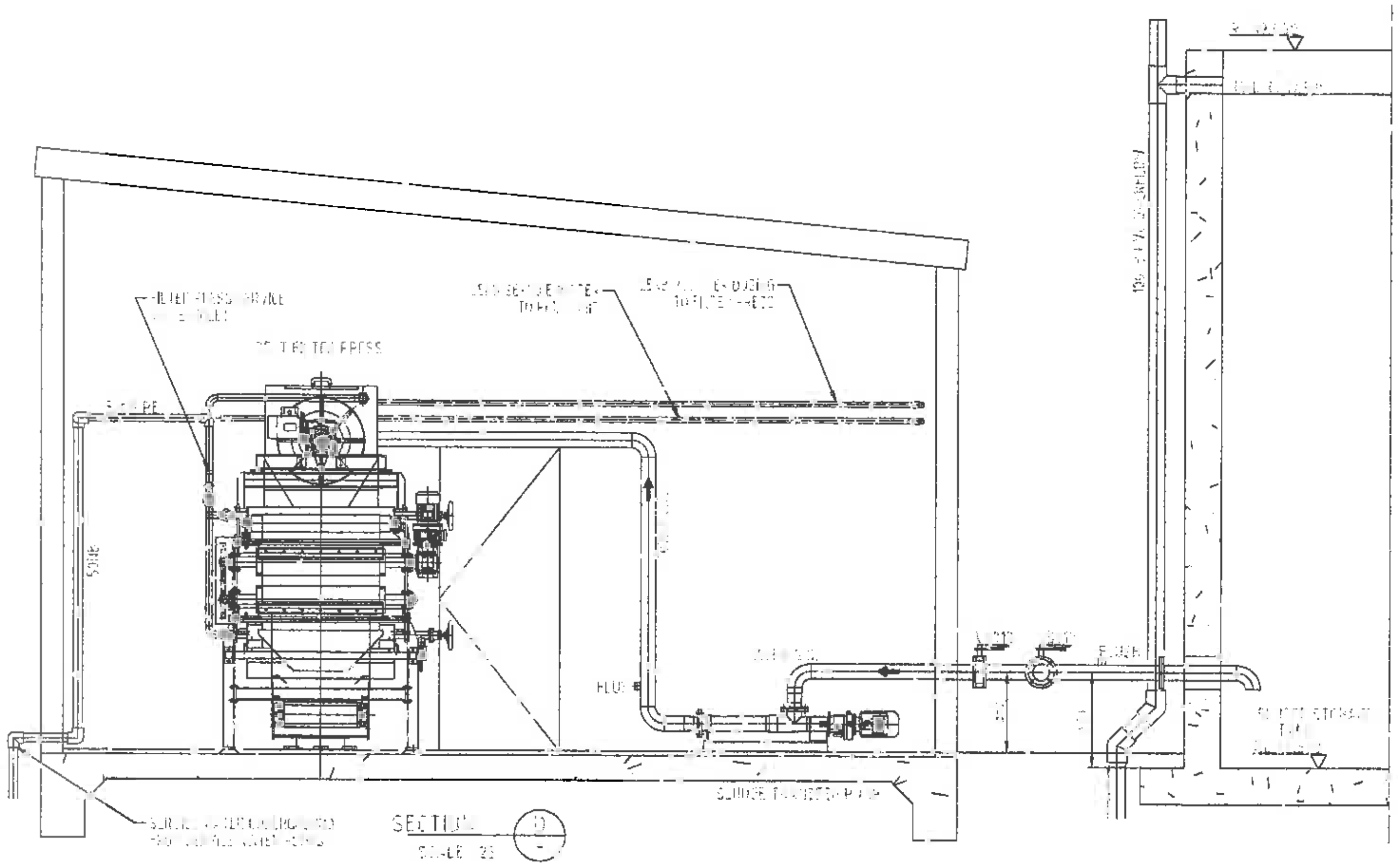
SLUDGE HANDLING AND BLOWER BUILDING ARRANGEMENT - PLAN (SHEET-1)

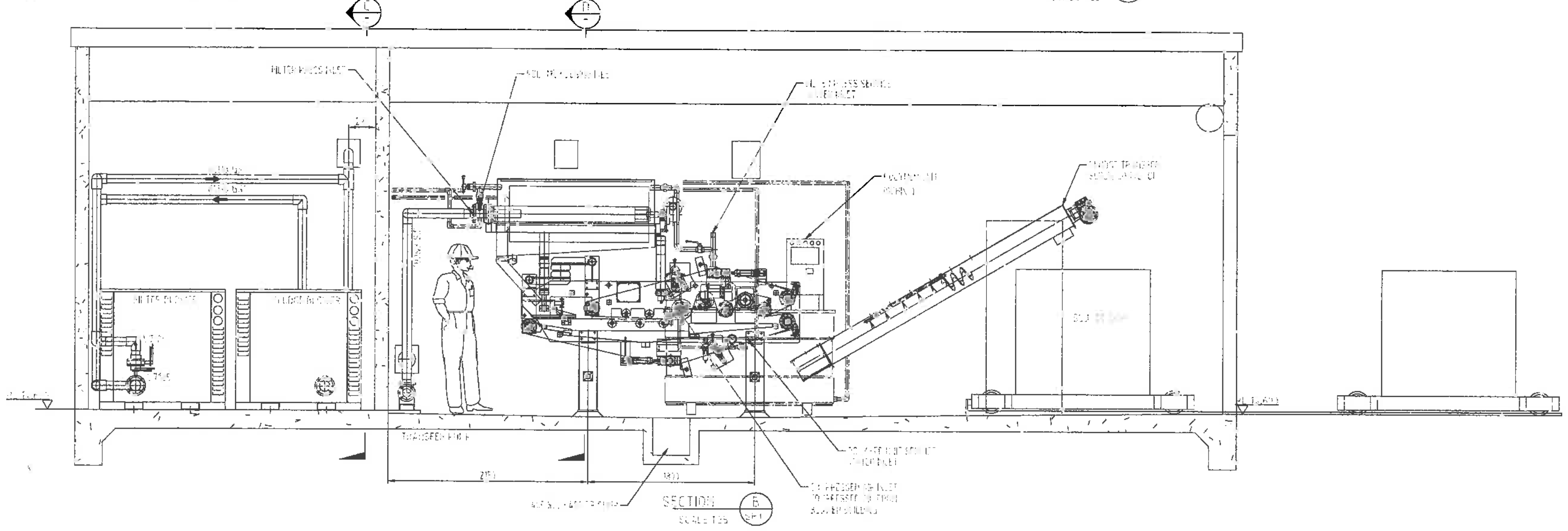
Drawing No. A-89973-CIV-7312A Rev 0

Sheet No. SHEET 1 89973

A1







0	AS BUILT		27.07.10		
REV	DESCRIPTION	DRN	DATE	CHK	APP

AS BUILT

0 0.5m 1m

Scale 1:25

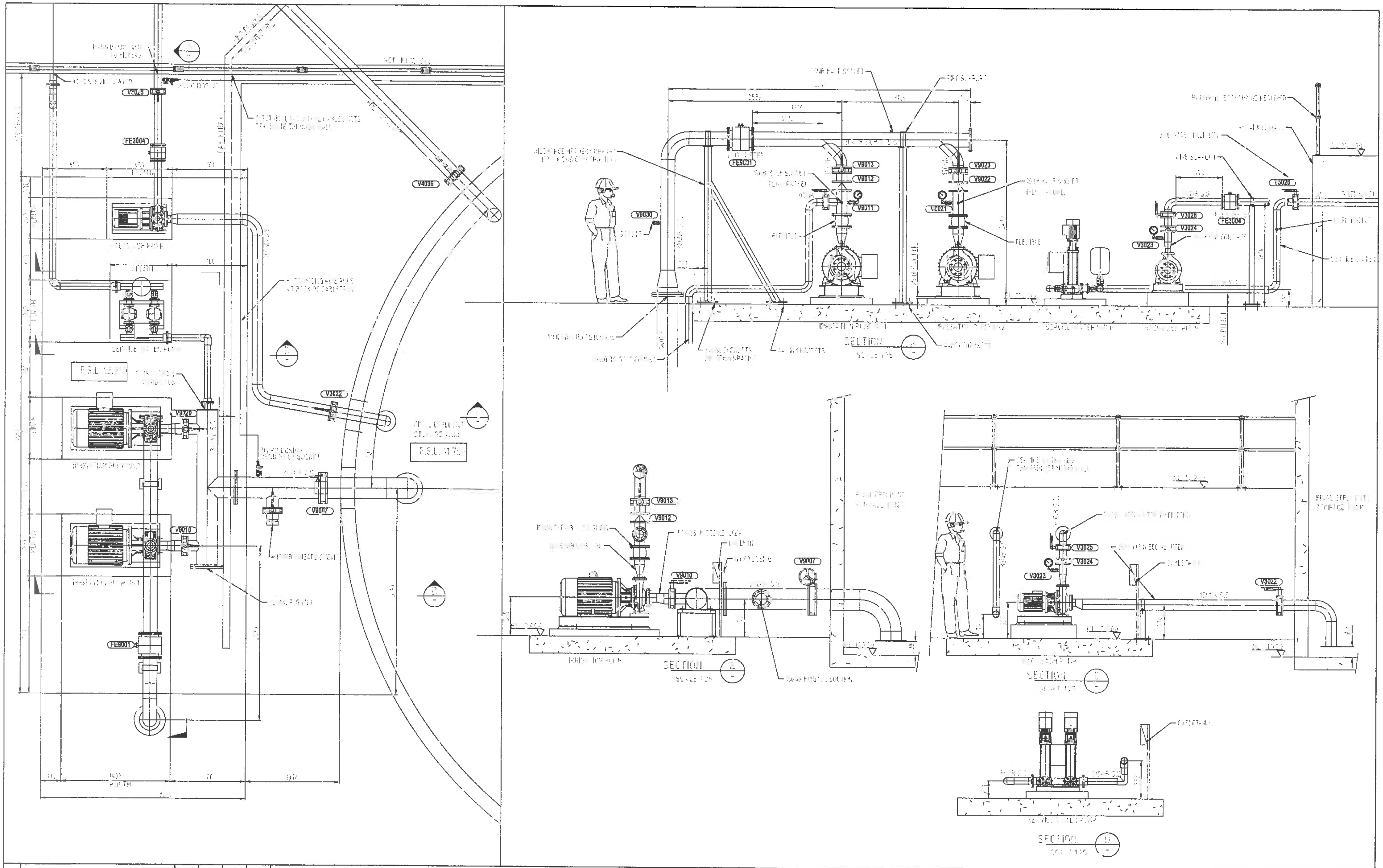
Water Infrastructure GROUP
A Tyco International Company

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

SLUDGE HANDLING AND BLOWER BUILDING
ARRANGEMENT - SECTIONS (SHEET-2)

Drawing No. A-89973-CIV-7312B Rev 0
Sheet No. SHEET 2 89973

A1



AS BUILT

REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

0 0 0.5m 1.0m

Scale 1:25

Water Infrastructure GROUP
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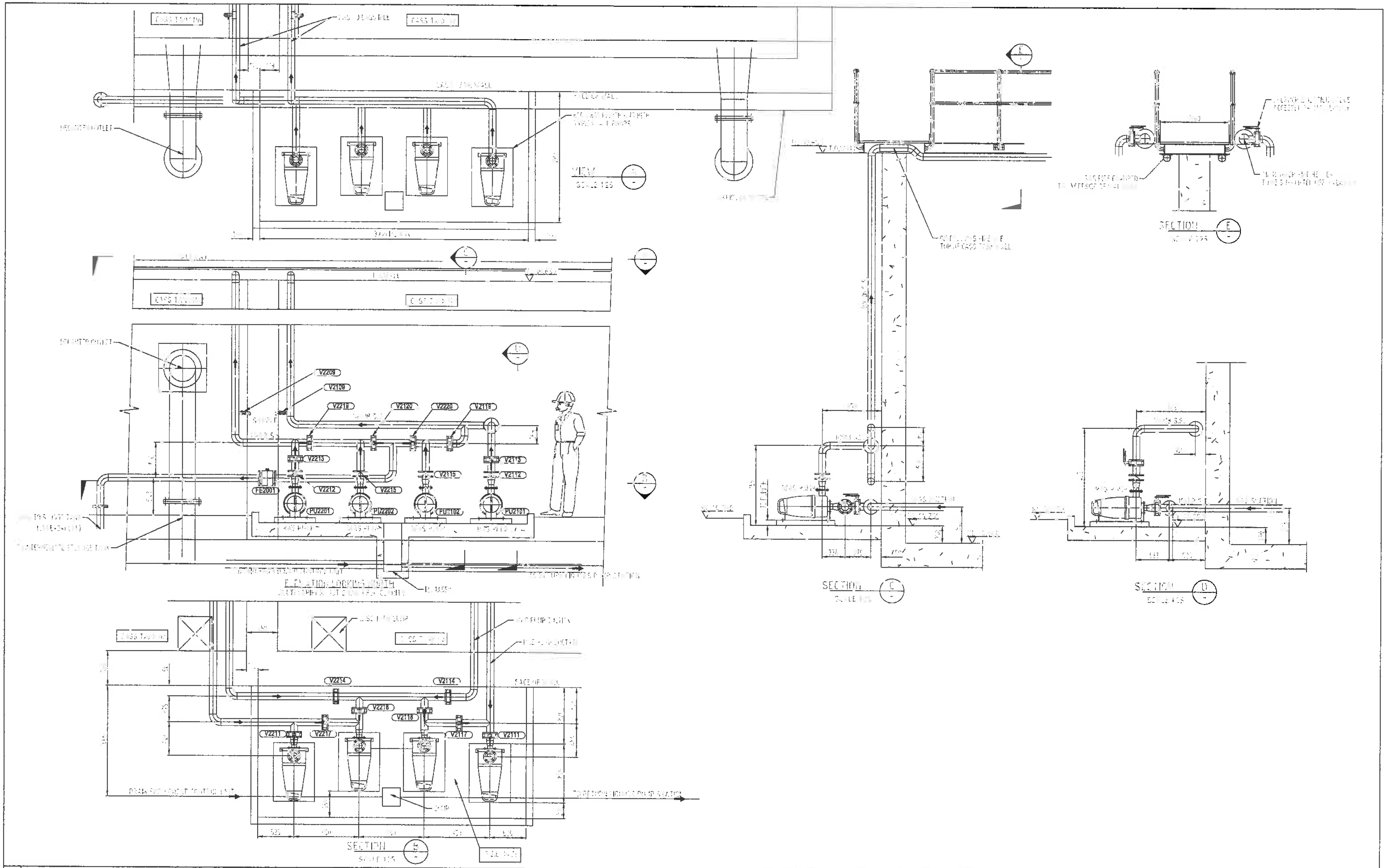
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

IRRIGATION TRANSFER/BACKWASH & SERVICE WATER PUMP ARRANGEMENT

Drawing No. A-89973-CIV-7313 Rev 0

Sheet No. 89973

A1



REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

0 0 0.5m 1.0m

Scale 1:25

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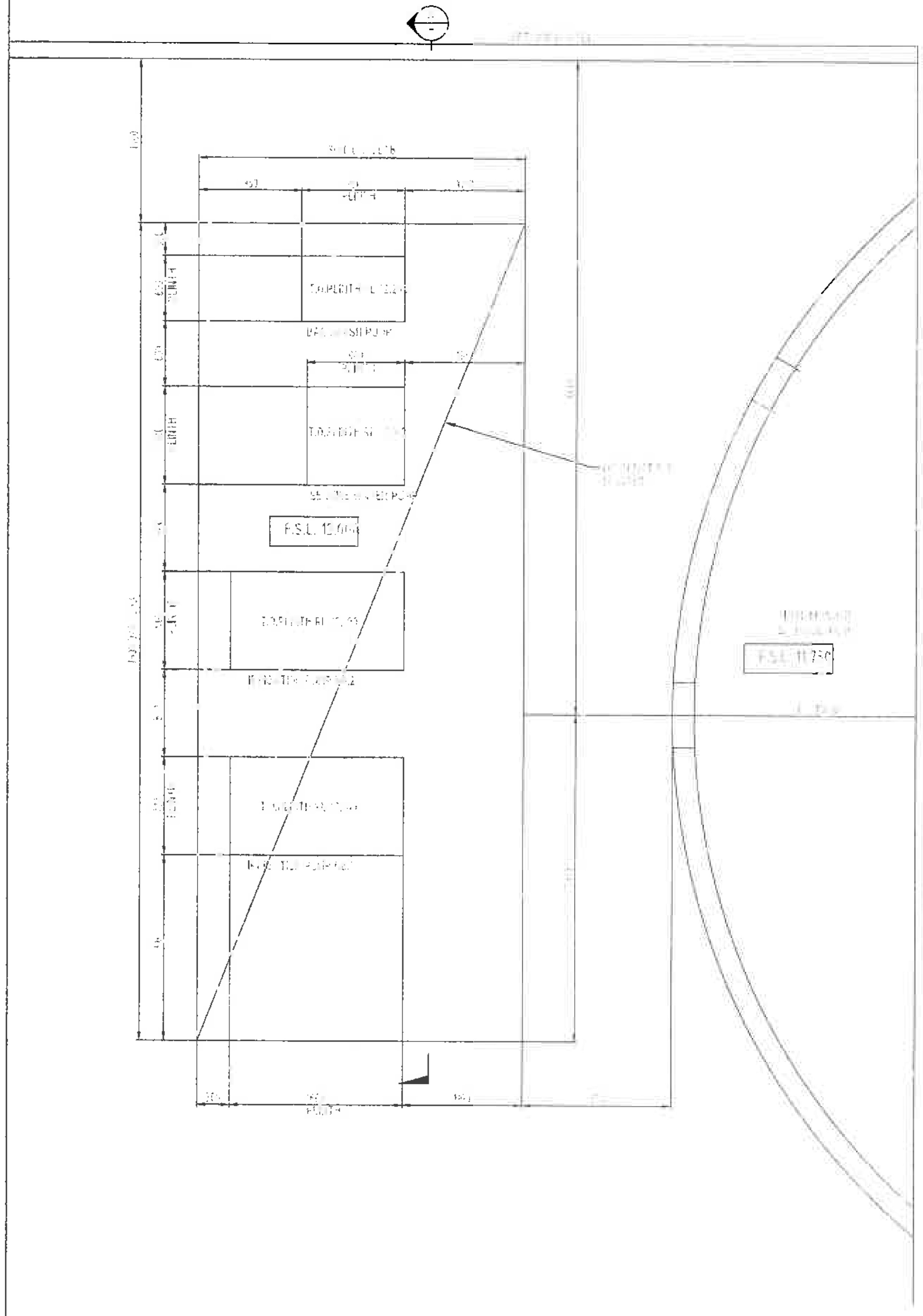
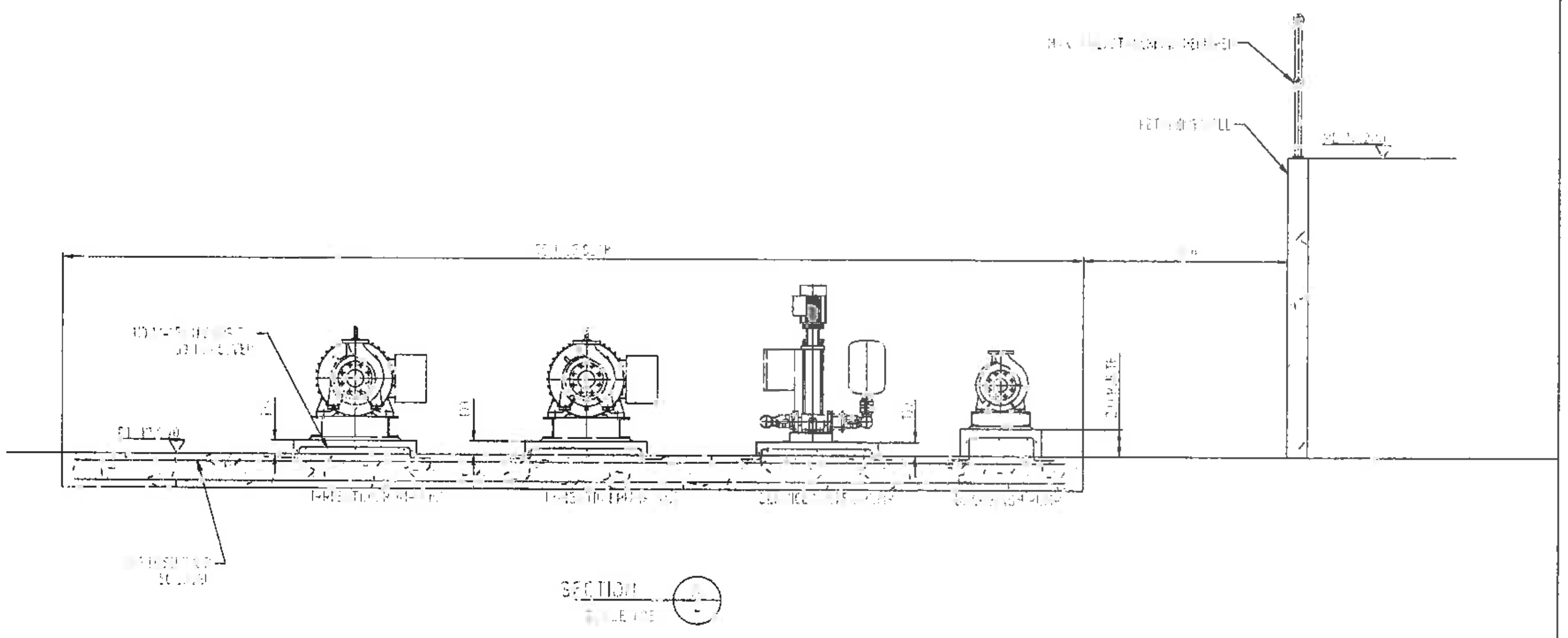
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

WAS & RAS PUMP ARRANGEMENT
PLAN AND SECTIONS

Drawing No. A-89973-CIV-7314 Rev 0
Sheet No. 89973

A1





REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

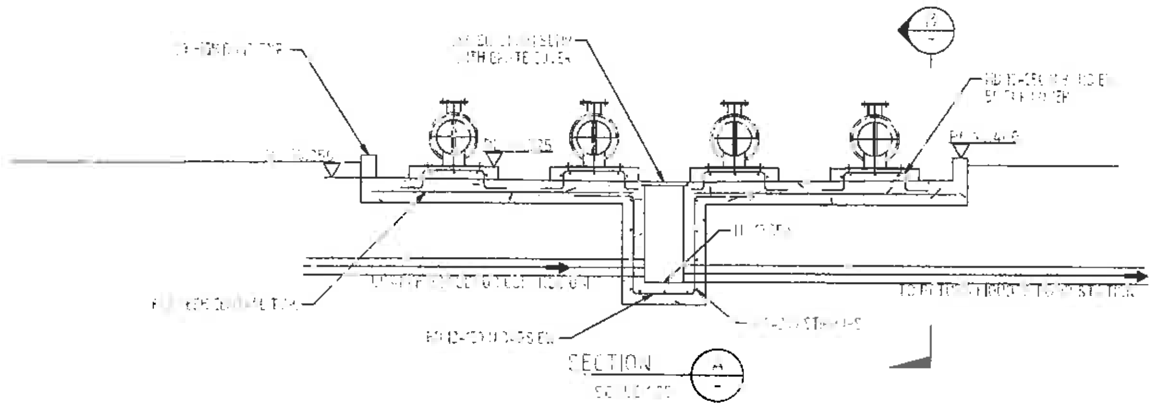
0 0 0.5m 1.0m
Scale 1:25

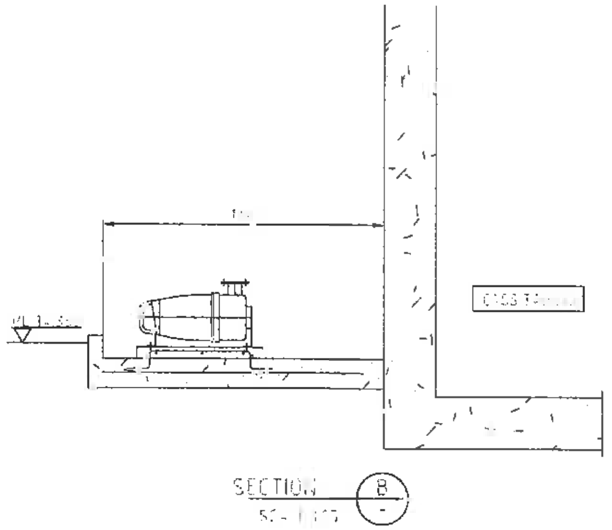
WaterInfrastructure GROUP
A Tyco International Company

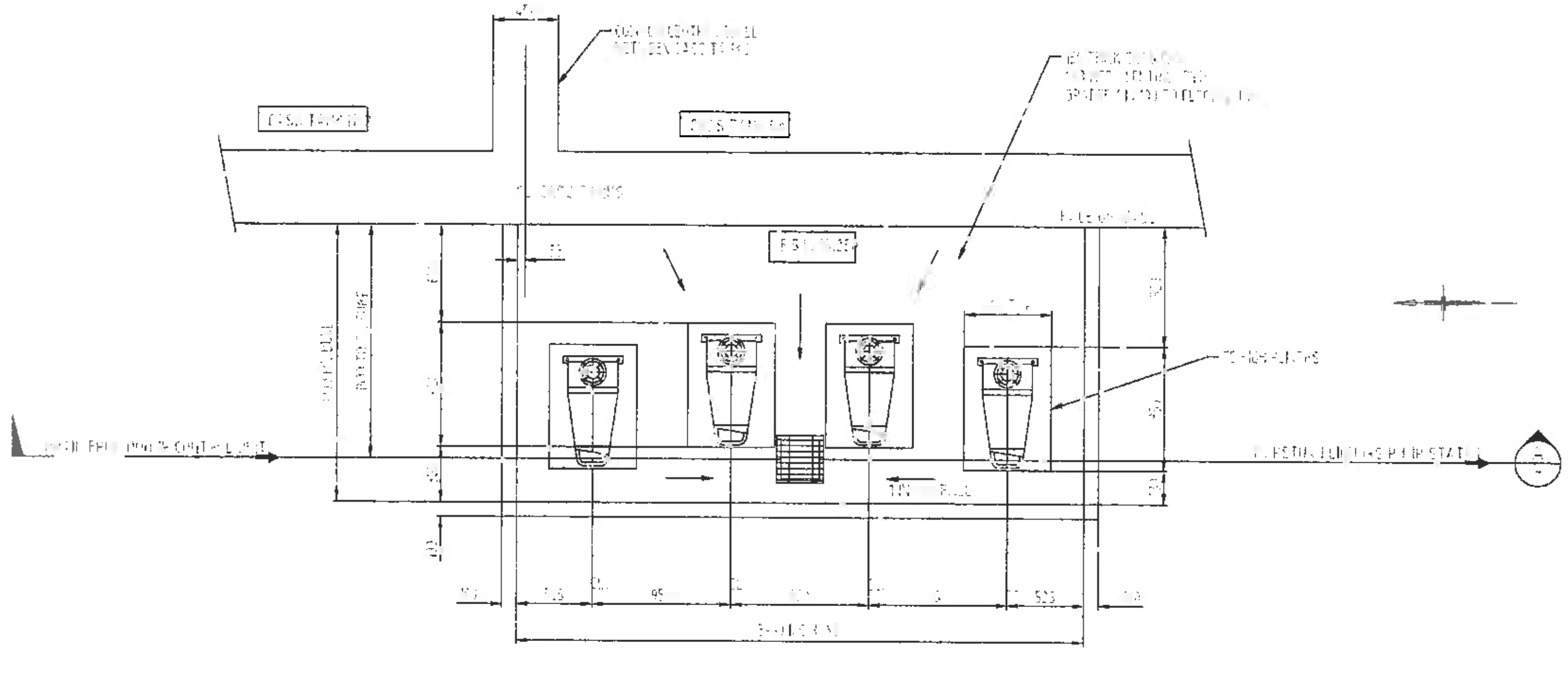
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

FINAL EFFLUENT TANK PUMP SLAB AND PLINTH DETAILS

Drawing No. A-89973-CIV-7315 Rev 0
Sheet No. 89973
A1







WAS / RAS PUMP SLAB DETAILS

REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

0 0 0.5m 1.0m

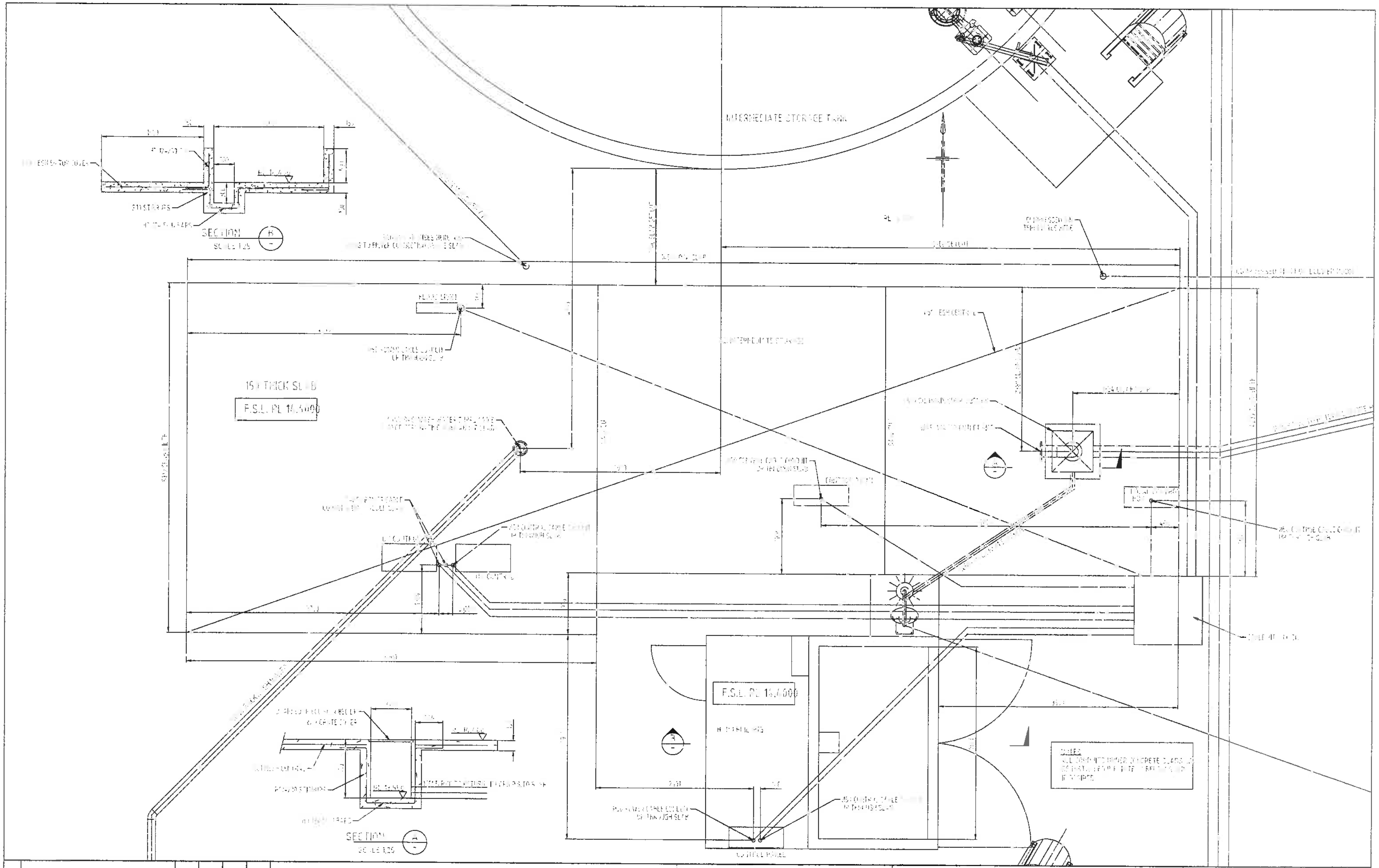
Scale 1:25

Water Infrastructure GROUP
A Tyco International Company

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

WAS & RAS PUMP ARRANGEMENT
PLAN AND SECTIONS

Drawing No. A-89973-CIV-7316 Rev 0
Sheet No. 89973
A1



AS BUILT

0	AS BUILT		27.07.10		
REV	DESCRIPTION	DRN	DATE	CHK	APP

0 0 0.5m 1.0m

Scale 1:25

Water Infrastructure GROUP
A Tyco International Company

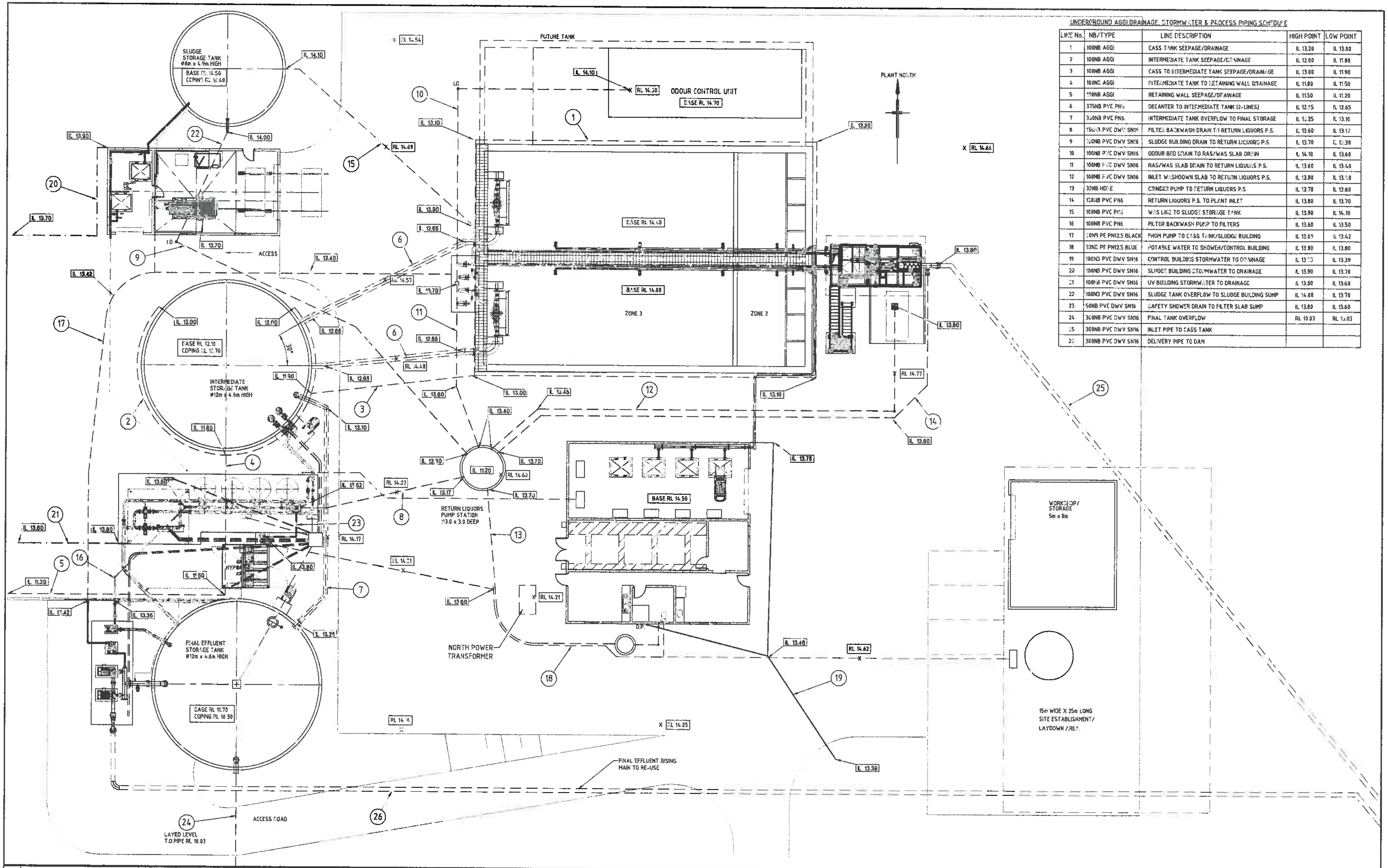
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

UV AND FILTER SLAB
CONCRETE DETAILS

Drawing No. A1-89973-CIV-7318 Rev 0

Sheet No. 89973

A1



UNDERGROUND AGGI DRAINAGE, STORMWATER & PROCESS PIPING SCHEDULE

LINE No.	NB/TYPE	LINE DESCRIPTION	HIGH POINT	LOW POINT
1	100NB AGGI	CASS TANK SEEPAGE/DRAINAGE	IL 13.20	IL 13.00
2	100NB AGGI	INTERMEDIATE TANK SEEPAGE/DRAINAGE	IL 12.00	IL 11.80
3	100NB AGGI	CASS TO INTERMEDIATE TANK SEEPAGE/DRAINAGE	IL 13.00	IL 11.90
4	100NB AGGI	INTERMEDIATE TANK TO RETAINING WALL DRAINAGE	IL 11.80	IL 11.50
5	100NB AGGI	RETAINING WALL SEEPAGE/DRAINAGE	IL 11.50	IL 11.20
6	375NB PVC PN6	DECANTER TO INTERMEDIATE TANK (2-LINES)	IL 12.85	IL 12.65
7	300NB PVC PN6	INTERMEDIATE TANK OVERFLOW TO FINAL STORAGE	IL 13.25	IL 13.10
8	150NB PVC DWV SN16	FILTER BACKWASH DRAIN TO RETURN LIQUORS P.S.	IL 13.60	IL 13.17
9	100NB PVC DWV SN16	SLUDGE BUILDING DRAIN TO RETURN LIQUORS P.S.	IL 13.70	IL 13.30
10	100NB PVC DWV SN16	ODOUR BED DRAIN TO RAS/WAS SLAB DRAIN	IL 14.10	IL 13.60
11	100NB PVC DWV SN16	RAS/WAS SLAB DRAIN TO RETURN LIQUORS P.S.	IL 13.60	IL 13.40
12	100NB PVC DWV SN16	INLET WASHDOWN SLAB TO RETURN LIQUORS P.S.	IL 13.80	IL 13.50
13	32NB HDPE	GRINDER PUMP TO RETURN LIQUORS P.S.	IL 13.70	IL 13.60
14	150NB PVC PN6	RETURN LIQUORS P.S. TO PLANT INLET	IL 13.80	IL 13.70
15	100NB PVC PN6	WAS LINE TO SLUDGE STORAGE TANK	IL 13.90	IL 14.10
16	100NB PVC PN6	FILTER BACKWASH PUMP TO FILTERS	IL 13.60	IL 13.50
17	50NB PE PN12.5 BLACK	FROM PUMP TO CASS TANK/SLUDGE BUILDING	IL 13.60	IL 13.42
18	32NB PE PN12.5 BLUE	POTABLE WATER TO SHOWER/CONTROL BUILDING	IL 13.80	IL 13.80
19	100NB PVC DWV SN16	CONTROL BUILDING STORMWATER TO DRAINAGE	IL 13.45	IL 13.39
20	100NB PVC DWV SN16	SLUDGE BUILDING STORMWATER TO DRAINAGE	IL 13.90	IL 13.70
21	100NB PVC DWV SN16	UV BUILDING STORMWATER TO DRAINAGE	IL 13.80	IL 13.60
22	100NB PVC DWV SN16	SLUDGE TANK OVERFLOW TO SLUDGE BUILDING SUMP	IL 14.00	IL 13.70
23	50NB PVC DWV SN16	SAFETY SHOWER DRAIN TO FILTER SLAB SUMP	IL 13.80	IL 13.60
24	300NB PVC DWV SN16	FINAL TANK OVERFLOW	RL 10.03	RL 10.03
25	300NB PVC DWV SN16	INLET PIPE TO CASS TANK		
26	300NB PVC DWV SN16	DELIVERY PIPE TO DAM		

REV	DESCRIPTION	DRN	DATE	CHK	APP
AC	AS CONSTRUCTED	DIJ	7.7.09	RJ	CJ
B	LINES 22 & 23 ADDED, LINE 10 RELOCATED	DIJ	13.1.09	CJ	RJ
A	ISSUED FOR INFORMATION	DIJ	8.1.09	CJ	CJ

AS CONSTRUCTED
Information supplied by construction contractor

mangawhai ecocare
Maintaining Our Environment

0 2.5m 5m
Scale 1:125

EARTH TECH
Global Water Projects and Products
Melbourne - Tel 8517 9200

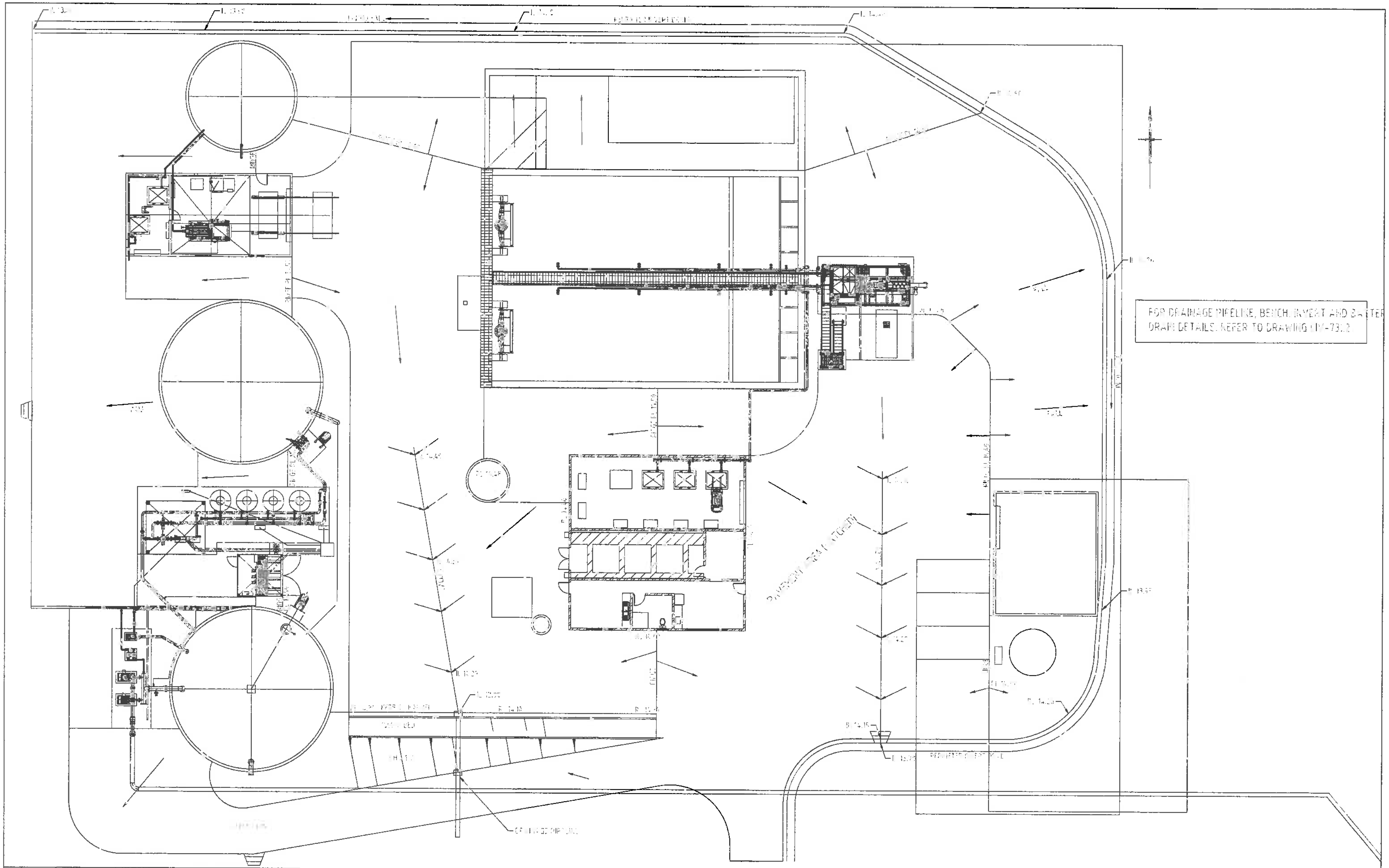
Designed C.JOHNSTON
Drawn D.JOULES
Checked C.JOHNSTON
Approved

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

TREATMENT PLANT
UNDERGROUND PIPING ARRANGEMENT

Drawing No. A-89973-CIV-7320 Rev AC
Sheet No. 89973

A1



FOR DRAINAGE PIPELINE, BENCH, INVERT AND BATTER DRAIN DETAILS, REFER TO DRAWING [illegible]

REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

Scale 1:130

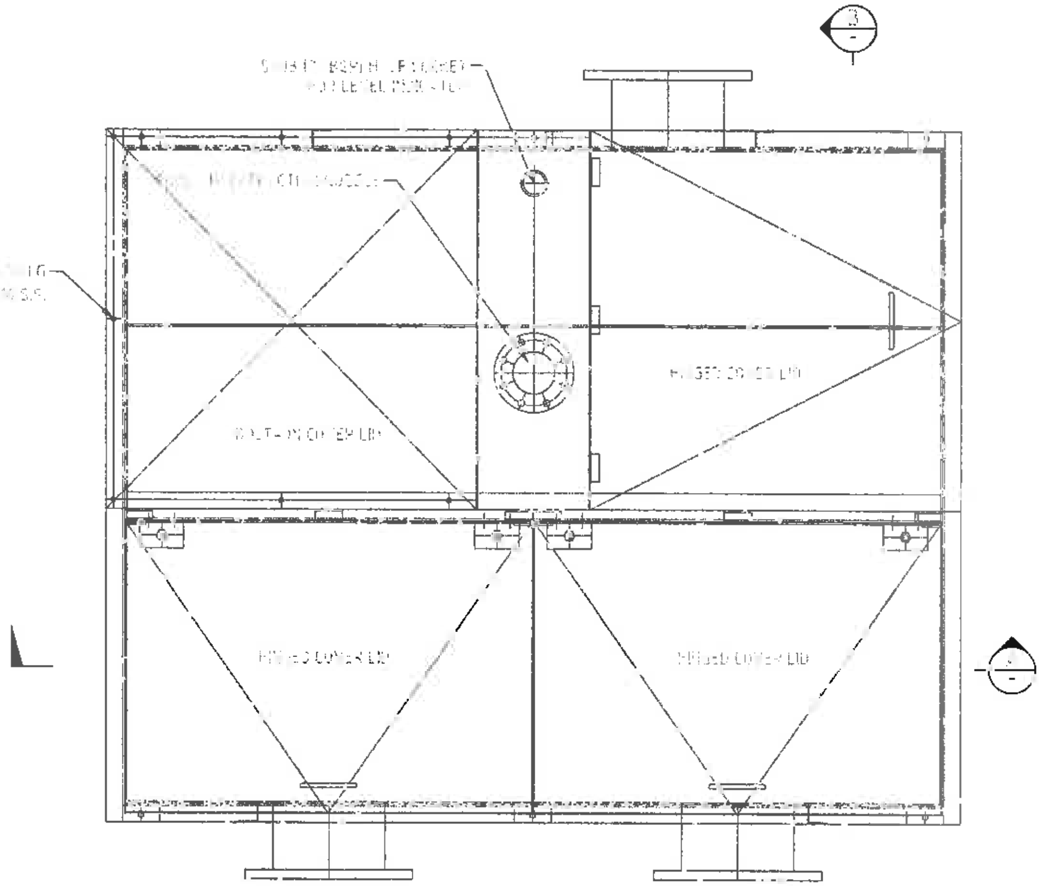
Water Infrastructure GROUP
A Tyco International Company

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

TREATMENT PLANT
FINISHED SURFACE LEVELS AND DRAINS

Drawing No. A-89973-CIV-7321 Rev A
Sheet No. 89973

A1



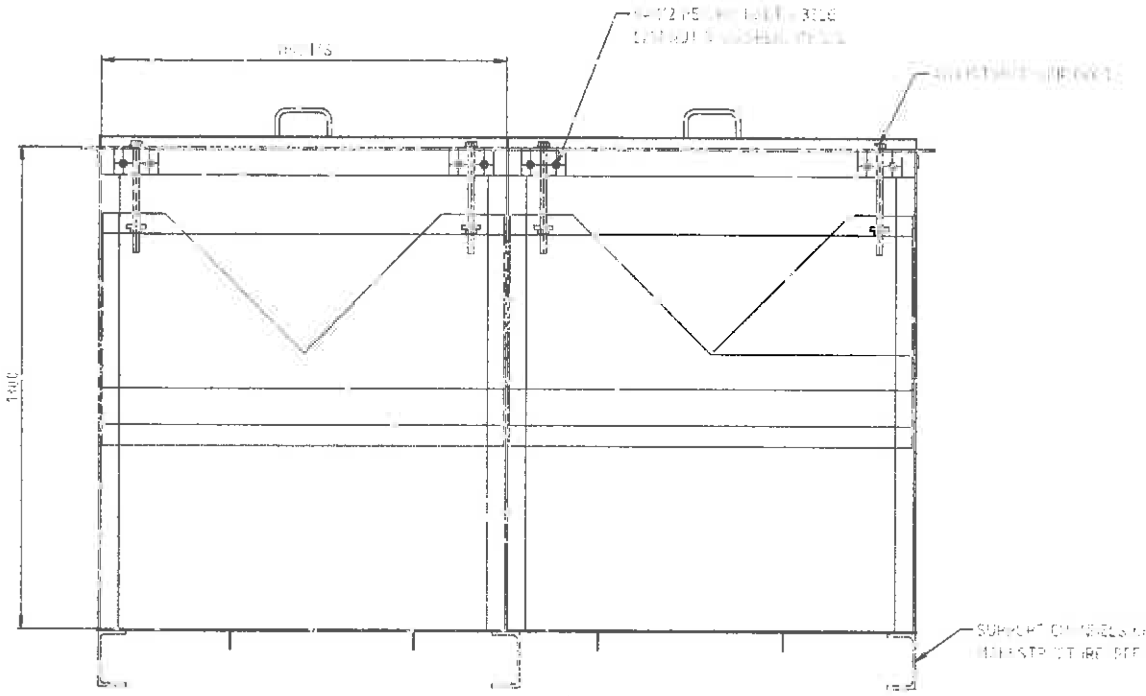
PLAN VIEW

[illegible]

REFERENCE DRAWINGS

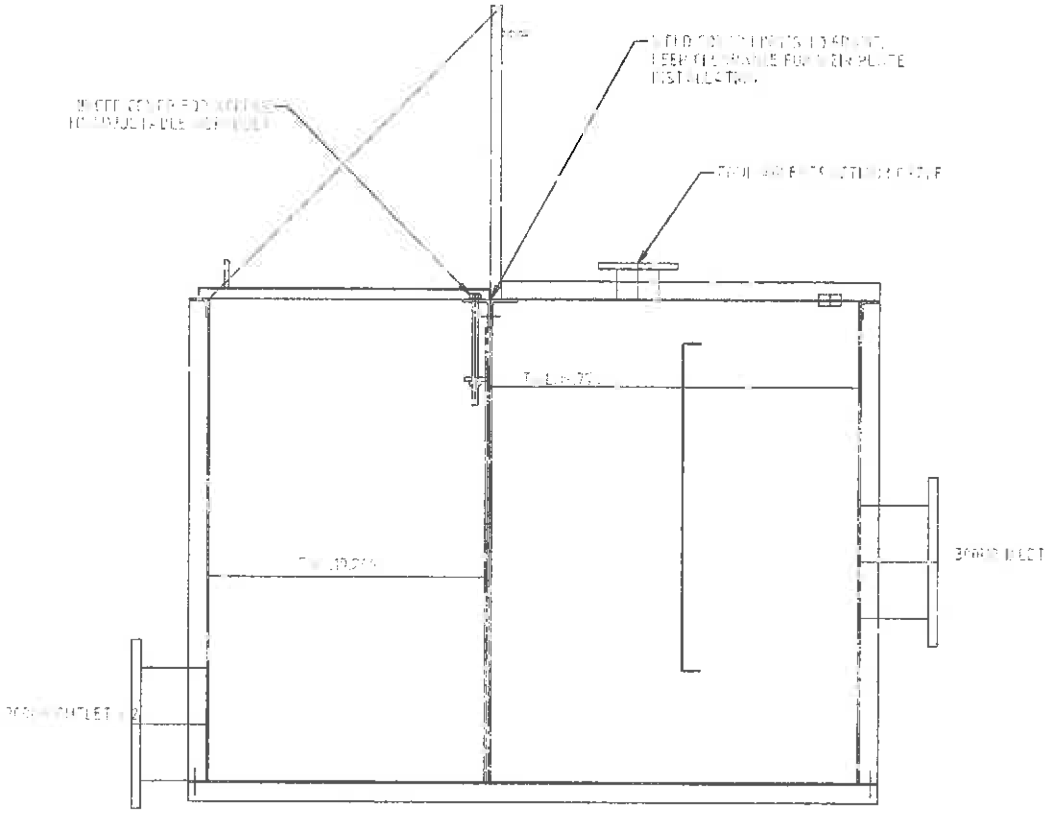
STR-7331 [illegible]

STR-7332 [illegible]



SECTION A

SCALE 1:10



SECTION B

SCALE 1:10

REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

Scale 1:10

Water Infrastructure GROUP
A Tyco International Company

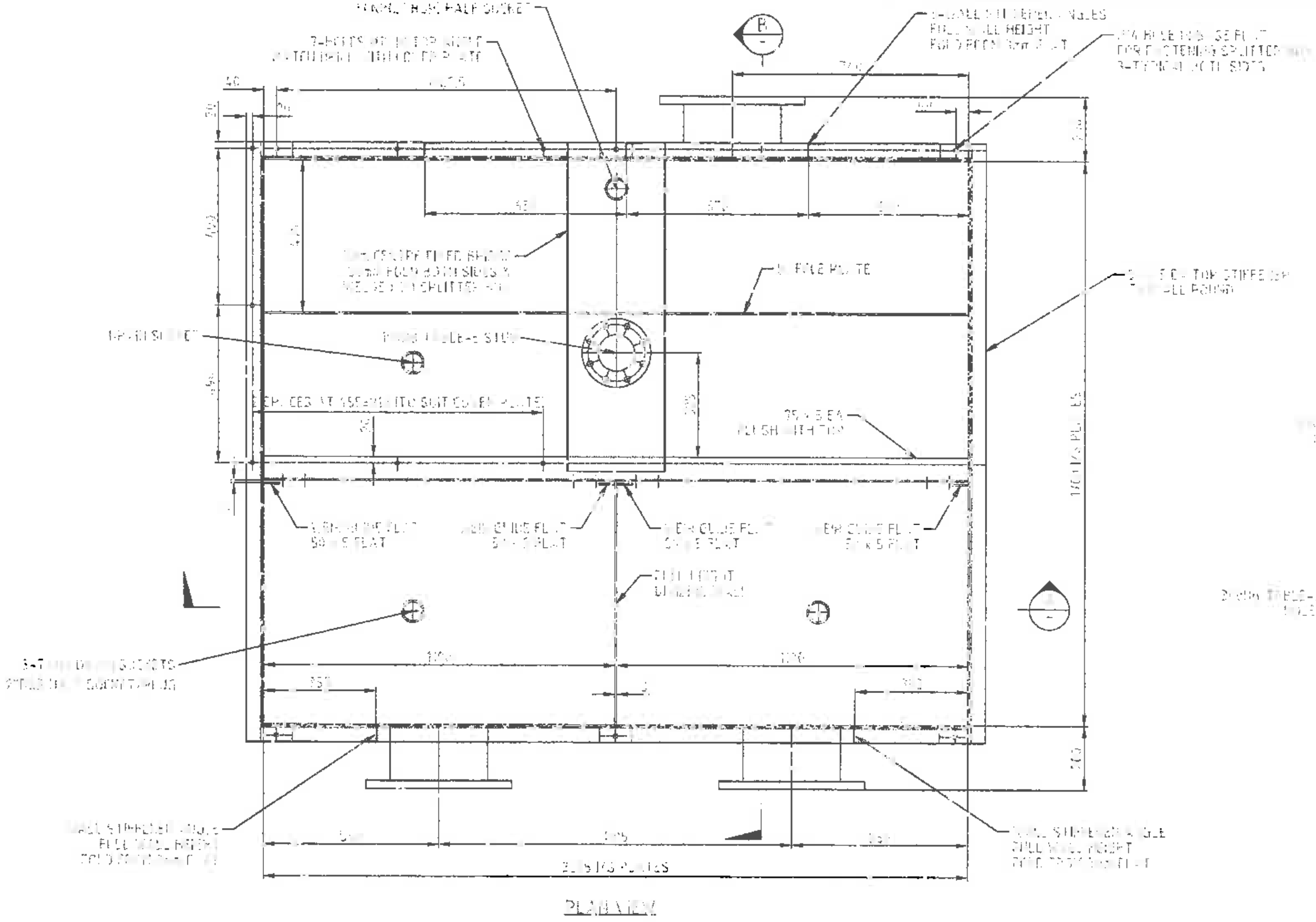
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

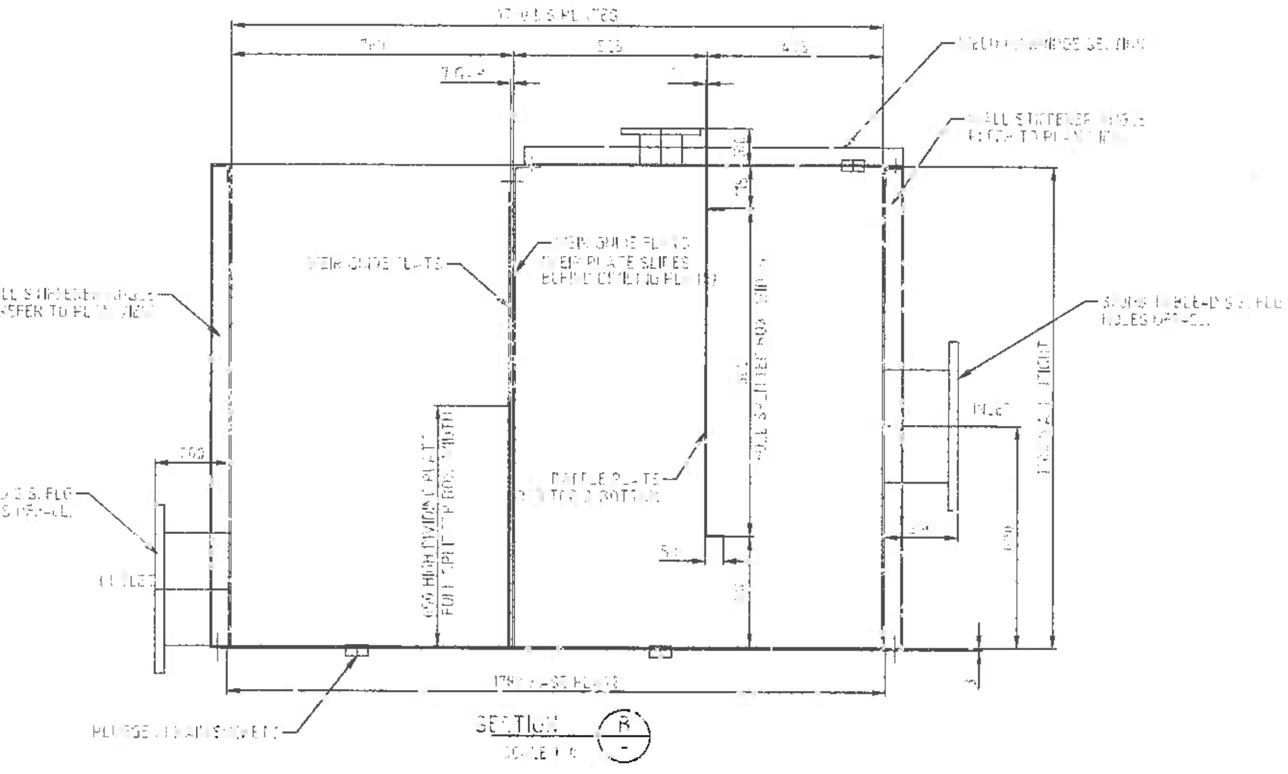
INLET WORKS
SPLITTER BOX ARRANGEMENT

Drawing No. A-89973-STR-7330 Rev 0
Sheet No. 89973

A1

NOTES
1. ALL MATERIAL TO BE 316 S.S.
2. BOX CONSTRUCTED TO BE 8mm PLATE UNLESS NOTED OTHERWISE
4. BASE AND SIDE PLATES TO BE FULLY SEALING WELDS.
5. ALL INTERNAL PLATES AND INTERNAL STIFFENERS TO BE STITCH WELDED.


PLAN VIEW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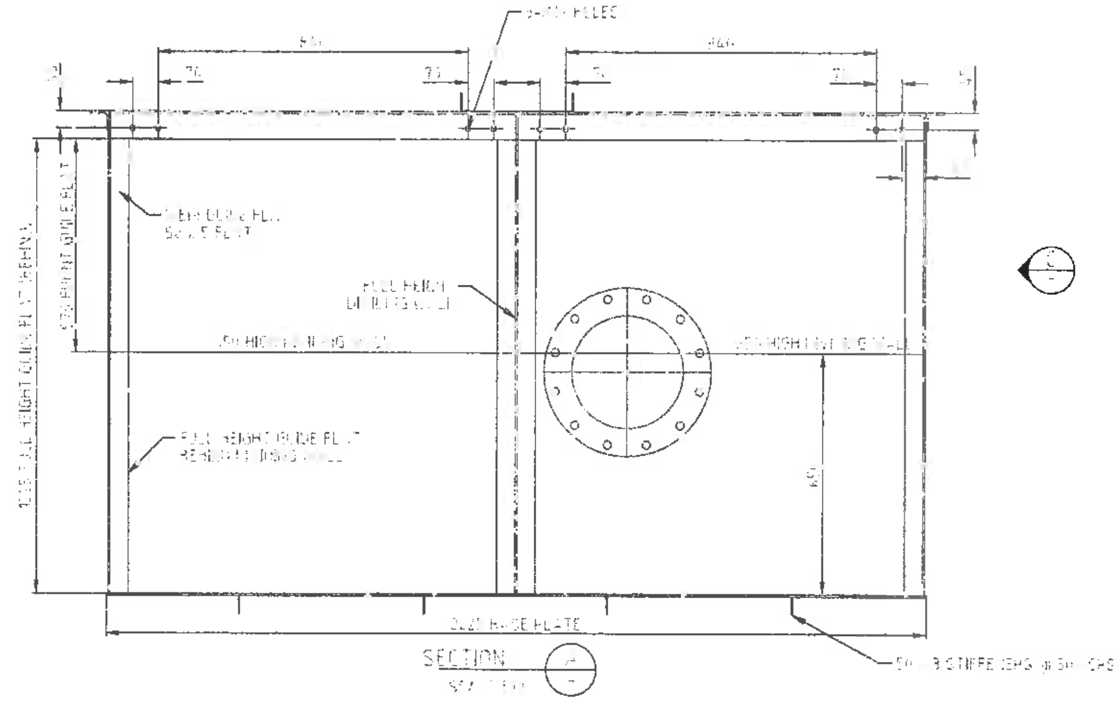
SCALE 1:10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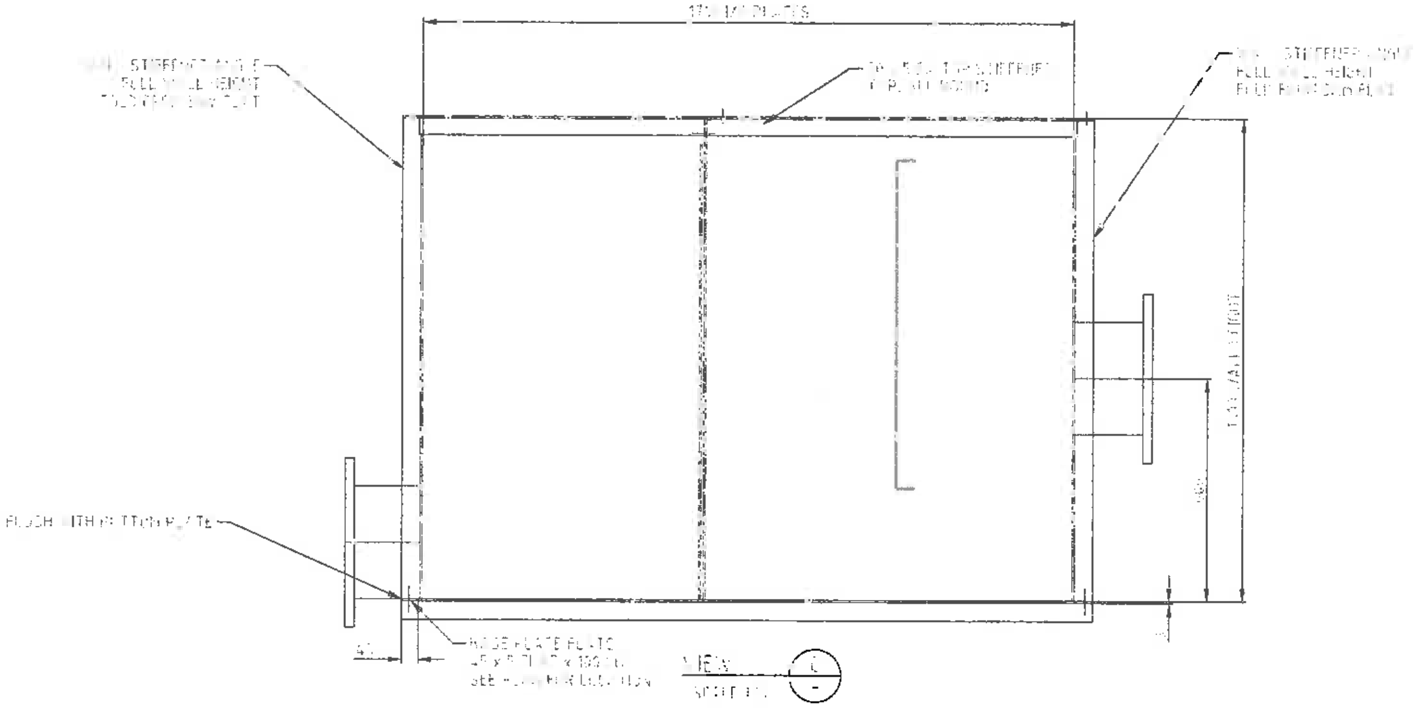
SCALE 1:10


VIEW C
SCALE 1:10

REV	DESCRIPTION	DRN	DATE	CHK	APP
0	AS BUILT		27.07.10		

AS BUILT

Water Infrastructure GROUP
A Tyco International Company

Scale 1:10

MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT

INLET WORKS
SPLITTER BOX DETAIL

Drawing No. A-89973-STR-7331 Rev 0
Sheet No. 89973

A1

Appendix B
Photos

Biofilter to be Removed

Biofilter and Bank on site of Balance Tank

Bank to be cut back for Construction

Base of Biofilter and Surface Material

Location of New Balance Tank

Back End of CASS and RAS Pumps

Location of New Balance Tank


Brush to be cleared


Bank to be Cut Back

Biofilter to be Removed

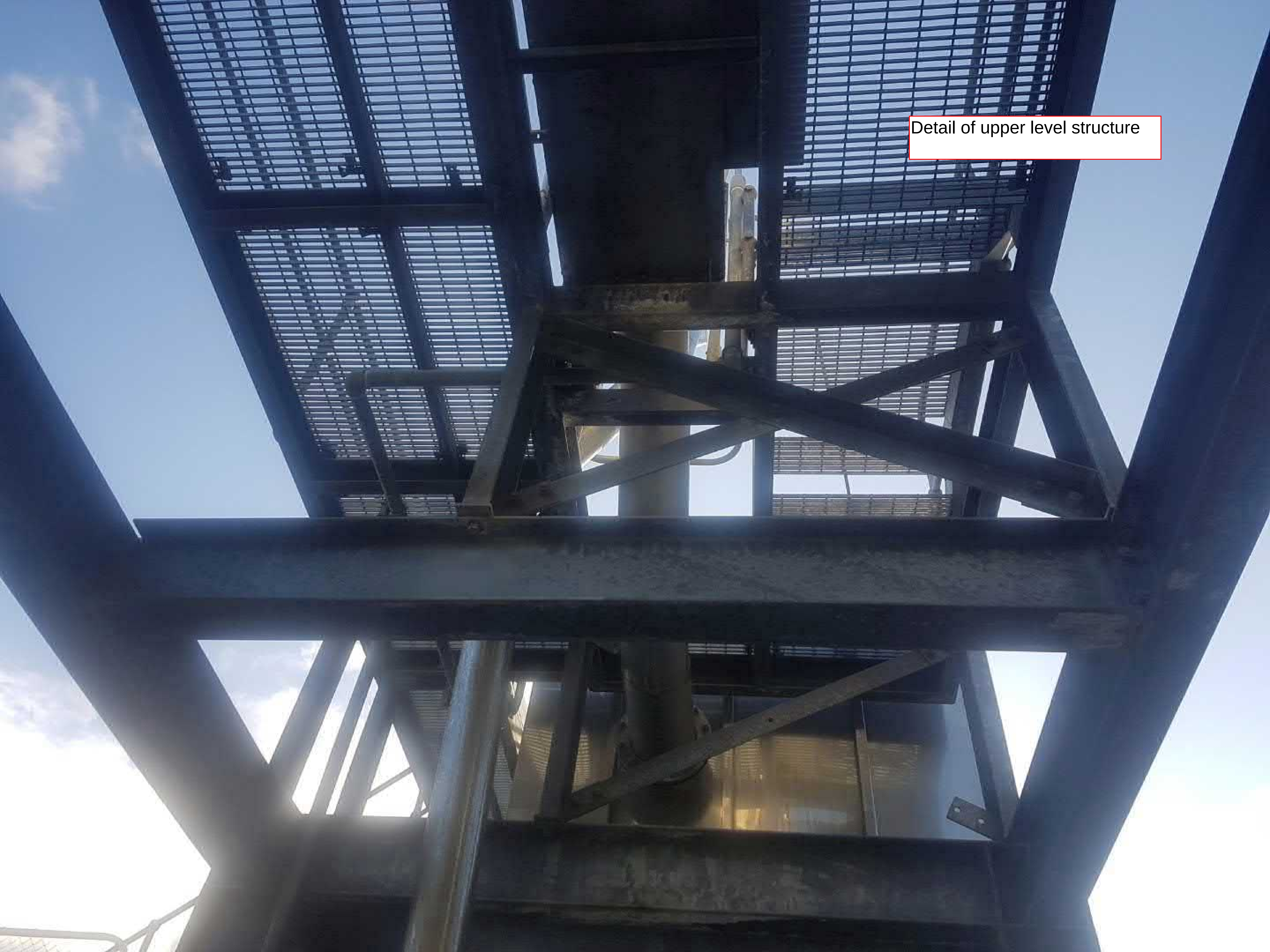
Surface Material on Balance Tank Area

Inlet Structure from East

Inlet Structure from South

Inlet with incoming Main

Underside View of Inlet Structure



Detail of upper level structure


Inlet Structure viewed from West

Access to CASS and Inlet

Stair Case and Mounting

SKIP AREA

CASS Inlet end and Internal Walls (New Balance Tank will not have internal walls)

CASS internal walls


CASS Reactor

General View of Balance Tank Area

General View of Balance Tank Area

Construction Joints in CASS Tank

Wall Detail CASS Tank

Appendix C
Hydraulic Profile Calculation

APPENDIX C Mangawhai Inlet Hydraulics Summary

S.No	levels	Calculated	From Drawings	
1	TWL in SBR	19.00	19.00	m
2	Headloss in discharge Pipework from Splitter Box to SBR	0.26	0.26	m
3	TWL in Splitter Box Outlet Side	19.26	19.26	m
4	V-Notch Weir IL	19.45	19.45	m
5	TWL Upstream of V-Notch Weir	19.77	19.77	m
6	Existing Screen IL	-	19.93	m
	Headloss Proposed Bypass to Ex Splitter	0.32		
7	TWL at proposed Bypass Chamber for 80 L/s	20.08	-	m
	Proposed Bypass Overflow Weir Level	20.18		
	Head over Rectangular Weir at 30 L/s	0.06		
8	TWL in Bypass Chamber @ 110 L/s	20.25	-	m
	Headloss Ex Screen to Proposed Bypass	0.26		
9	TWL at Screen Outlet	20.51	-	m

Height to Raise without any surcharge 0.58

Appendix D

Geotechnical Desktop Study

Kaipara District Council

MANGAWHAI COMMUNITY WASTEWATER TREATMENT PLAN EXPANSION (STAGE 1)

GEOTECHNICAL DESKTOP STUDY

31 JULY 2020

PUBLIC

Question today
Imagine tomorrow
Create for the future

MANGAWHAI COMMUNITY WASTEWATER TREATMENT PLAN EXPANSION (STAGE 1)

GEOTECHNICAL DESKTOP STUDY

Kaipara District Council

WSP
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Mansfield Terrace Service Lane
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PO Box 553
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wsp.com/nz

REV	DATE	DETAILS
0	29 July 2020	First Issued Report

	NAME	DATE	SIGNATURE
Prepared by:	Dave WITJAKSONO	29 July 2020	
Reviewed by:	Glyn EAST		
Approved by:	Eros FOSCHIERI		

Our ref: 1-14129.07

29 July 2020

Matthew Smith
Kaipara District Council
41 Hokianga Road
Dargaville
0310, New Zealand

Dear Matthew

Geotechnical Desktop Study – Mangawhai CWWTP Expansion (Stage 1)

This report presents the summary of our review we carried out to the site subsurface conditions and the geomorphology of the site based on the existing available information, and provides preliminary comments and recommendations for the proposed development of another two balance tanks to the northeast of the existing CASS tank.

Our general review of the available information indicates the site is generally geotechnically suitable for the proposed development. Specific comment in this regard is provided within this report.

Dave Witjaksono
Senior Geotechnical Engineer

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

This geotechnical desktop study report was prepared by WSP for Kaipara District Council (KDC) in association with the proposed expansion of Mangawhai Community Waste Water Treatment Plan (CWWTP) Stage 1 as mentioned on WSP letter of service to KDC (Offer of service letter, Ref.: 1-14159.00, dated 17 June 2020). The purpose of this assessment has been to perform desktop study on the available geological, geotechnical and geomorphology information relevant for the current proposed expansion of the plant.

1.2 OBJECTIVES AND SCOPE OF WORK

In this financial year 2020/21 the proposed facility expansion is to build another two balance tanks immediately to the northeast of the existing CASS tanks. To facilitate the development of this facility, the scope of work has comprised the following:

- Desktop review of the geotechnical investigation report for the existing plant with its relevancy to the prevailing building codes;
- Provide assessments on of potential geohazard and constraints for the proposed development;
- Should it be needed, propose the required geotechnical investigation; and,
- Preparation of this Stage 1 Preliminary Geotechnical Desktop Study report.

2 SITE APPRAISAL

2.1 SITE DESCRIPTION

The site of the existing plant is situated on the westside on an isthmus which is surrounded by Mangawhai Harbour inlet on its eastern, southern, and western perimeter. The existing plant lies on a flat terrain but gently sloping to the south with the current existing CASS tank lies below the low hilly dunes to the southeast perimeter of Mangawhai Heads Golf Club. The current plant is accessible from short distance access road off the northeast side of Thelma South Road.

2.2 GEOLOGICAL REVIEW

Review of the geological formation for the site was carried out from the available online information published by the Geological and Nuclear Science (GNS website). The physiographic features of this area are mainly fluvial and coastal plains. The data from GNS website indicates that the site is underlain by late Pleistocene parabolic dune sands sediments of Kariotahi Group which (Quaternary sands) with the lithology [1Qd]. This late Pleistocene dune sands is considered aged (>100,000 years) which is likely less susceptible to liquefy for the triggering events from this area.

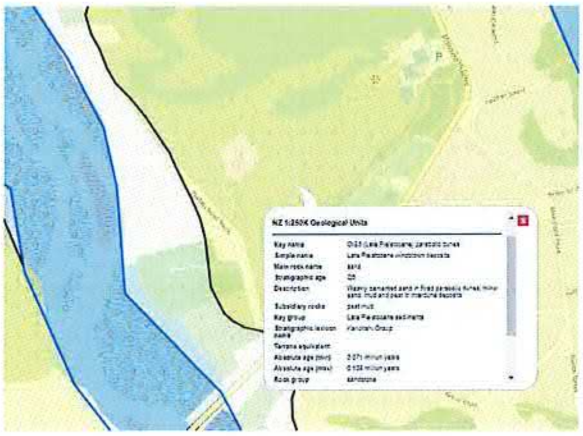


Figure 1: Geological Review from GNS.

Edbrook reported that this Pleistocene dune sands deposition comprises of weakly cemented and moderately consolidated to unconsolidated coastal sand deposits of shallow marine, beach and dune origin. Younger depositions of Holocene-aged fixed dunes overlay the Pleistocene dunes behind the active dune deposits on the coast. This formation has been actively vegetated despite its lacks well-developed soils.

There is not known of any active fault within the proximity of 500km from this this area.

2.3 SUBSURFACE CONDITION

The geotechnical investigations undertaken by Tonkin and Taylor in May 2006 comprised a total of 4 boreholes with SPT and 5 Cone Penetration Tests (CPT). These boreholes were drilled to a maximum depth of 10 m below the existing ground level. The CPT were pushed to maximum depth of 15 m. Two of boreholes were installed with piezometers with screening filter on the bottom 2 – 3 m. Copies of the historic soil investigation logs and the CPT records are attached to this report together with a site plan showing their locations.

The borehole logs indicate that majority of the site was underlain by quaternary sands with the sequence of geology as the following prior to the development of the current plant:

- 0 m to 0.5 m below ground level: Topsoil;
- 0.5 m to 10.0 m below ground level: Estuarine deposits (CPT1, 2, 3, 4 and BH4), and;
- 10.0 m to end of boreholes: Quaternary sands (BH1, 2, 3, and CPT 5).

This estuarine deposit is likely formed from the water body trapped behind sand dunes. The estuarine deposits comprise of fine to medium grained sands with high plasticity silts and clays with some organic, having SPT'N' value from 2 to 9. The CPT readings suggested that this deposit is prevalent in most of the area at shallow depth, which is quite inconsistent with the adjacent boreholes and the recorded SPT'N' values.

The Waitemata formation Group is likely present beneath these dune sands formation at the depth of about 16 m.

2.4 GROUNDWATER

From the two piezometers on the site, it was recorded groundwater level of about 4 – 6 m below ground level which were taken during the wet period in June 2006. Despite this level is considered deep as to trigger liquefaction on this aged dense sand, the new proposed CPT will provide factual results to the issues.

3 GEOTECHNICAL ISSUES

We consider that the site is generally suitable for the proposed development of another two balance tanks to the northeast of the existing CASS tank. However, the presence of soft silty clay deposits which were recorded by the historical CPT at shallow depth should be considered as part of the due diligence process. Therefore, for the proposed future developments, at least another four CPTs are required to be placed to refusal with two of them within the footprint of the new proposed tanks structure with another two to the northwest of the existing intermediate storage tank. The plan showing the proposed CPT location is enclosed behind.

These new CPT readings together with the historical boreholes from Tonkin & Taylor will be used to develop for a new geological model which runs from northeast to southwest direction. As we were unable to obtain these historical CPT soft data for our processing, the new CPT data will be used to assess the liquefaction potential for the new developments in this area and the future expansion.

3.1 FOUNDATION DESIGN

The new balance tank is likely to be similar in shape and size to the adjacent CASS tank with footprint dimension of 20 x 15 sqm. With the tank stand of about 5 m above ground with 1 m embedment, it is expected to have maximum distributed pressure of about 60 kPa. An underground perimeter drainage should exist around this structure at the soffit level of the footing considering the high permeability of the foundation soils.

Where heavy loaded structure cannot be sufficiently supported by shallow foundations, a distributed raft foundation or slab below ground may be required. Pile foundation is unlikely required on this soil materials unless the new CPT result indicate that the ground is prone to liquefaction triggering in this area.

All foundation should extend below the topsoil materials by extending them to at least 0.5m depth. With all the structures founded on medium dense to stiff silts and loose sands of the quaternary deposition without any immediate soft compressible materials underneath and the groundwater is kept far below the foundation width, the foundation load is limited to an Ultimate (Rupture) Bearing Capacity of at least 300 kPa.

3.2 GROUND SETTLEMENT

The static ground settlement is likely to occur immediately during the construction of the new tanks structures. The total settlement of structures designed with an ultimate bearing capacity of 300 kPa is estimated to be between 10 mm and 20 mm. Increased bearing capacities may be possible, subject to favourable results from the new proposed CPT.

3.3 SITE EARTHWORKS

There is no record available from the earthworks which were carried out for the construction of the existing plant. However, we were made aware that the exiting plant were placed on the top of a maximum of 1 m of compacted fill materials which presumably was obtained locally. And we believe the all topsoil and unsuitable materials were stripped prior to the placement of this bulk fill.

Should the undulating hill on the northeast require cutting to allow for a flat platform for the new balance tanks, all new slope required to be battered with gradient of (V): (H) = 1: 2.5 for a maximum 2.5 m high with setback of 1 m wide terraces. To prevent the new cutting hill from wind erosion, replanting with the local scrubs and grass is advisable.

As the new balance tank requires excavation for placing the soffit level of the foundation, all short term battered can be safely achieve with gradient of (V): (H) = 1: 2 for a maximum of 2 m cut slope.

3.4 GEOTECHNICAL DESIGN PARAMATERS

Based on our review of the historical boreholes for the development of the existing plant, geotechnical parameters have been derived for each soil consistency encountered from each borehole and is presented on table below. These parameters have been assumed for engineering analysis including slope stability assessment, foundation design and retaining wall design.

Table 1 Geotechnical Design Parameters

SOIL CONSISTENCY	UNIT WEIGHT [KN/M³]	EFFECTIVE FRICTION ANGLE [DEGREE]	EFFECTIVE COHESION [KPA]
Loose Sand	18	30	0
Med Dense Sand	18	32	0

3.5 PAVEMENT

We recommend heavy traffic be design using a subgrade CBR of 5. Proof rolling should be carried out under the supervision of a suitably qualified engineer or geologist, to confirm that the subgrade has the required stiffness. Any soft spots encountered should be sub-excavated and replaced with well compacted and well graded hardfill.

3.6 SITE SEISMICITY

Mangawhai CWWTP site is distant from any known geological active faults. Based on New Zealand Standard for Structural Design Actions (NZS 1170: 2004) favourable method for seismic site determination from shear wave velocity, we have carried out independent check from SPT'N' reading. In terms of NZS 1170, the site subsoil category should be taken as Class C (shallow soil sites).

For geotechnical design a horizontal seismic acceleration = 0.18g (ULS) and 0.03g (SLS1) may be used. This is derived using the following factors $C_{0,1000}$ = 0.1g, R_u = 1.8 (ULS) and 0.25 (SLS1) and assuming a 1 in 2500-year event (ULS) and 1 in 25-year (SLS1).

3.7 LIQUEFACTION POTENTIAL

We were unable to obtain the soft data from the historical CPT for liquefaction potential assessments. With the fine-grained soil silty sands and sandy silts encountered on site and groundwater table is relatively high, we shall address this following the new CPT results.

APPENDIX A

HISTORICAL SPT

P:\23428\23428.001\WorkingMaterial\23428.001-01.dwg, -01, 23/06/2006 4:36:09 p., Ran

0	First Issue		
REVISION DESCRIPTION	BY	DATE	

DESIGNED :	JRL	May.06
DRAWN :	AMM	May.06
DESIGN CHECKED :		
DRAFTING CHECKED :		
CADFILE : P:\23428\2342..\23428.001-01		

APPROVED :

NOT FOR CONSTRUCTION

This drawing is not to be used for construction purposes unless signed as approved

NOTES:

1. All dimensions are in metres unless noted otherwise.
2. Base drawing supplied by: Geo Smart Ltd (Job Title Mangawhai O-tho Resupply, Job Number PGRM 1617)

REFERENCE :

Tonkin & Taylor
Environmental & Engineering Consultants
Auckland 105 Carlton Gore Rd. Newmarket
Tel. (09) 355 6000 Fax. (09) 307 0265
Email : auck@tonkin.co.nz
www.tonkin.co.nz

CLIENT, PROJECT
EARTHTECH ..
MANGAWHAI SEWER PROJECT

TITLE
GEOTECHNICAL INVESTIGATION
FILED INVESTIGATION PLAN

SCALES (AT A3 SIZE)	DWG. No.	REV.
1: 1000	23428.001-01	0

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH1
Hole Location: GPS mark 39
SHEET 1 OF 1

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 15/5/06
HOLE FINISHED: 15/5/06
DRILLED BY: LDE
LOGGED BY: SJWW **CHECKED:** JRL

GEOLOGICAL / **ENGINEERING DESCRIPTION**

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION	CORE RECOVERY	METHOD	TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL		AUGER			MH	VSt	SILT, some fine sand, moderately to highly plastic, stiff to very stiff, some roots in top 200mm, grey brown.
QUARTERNARY SANDS							NO RECOVERY.
					MH		SILT, some fine sand, some clay, very stiff, highly plastic, wet, light grey (very), mottled light orange brown.
				1	SM	L	SAND (fine), loosely packed, moist to wet, occasional black carbonaceous specks throughout, light orange brown.
	450	SPT	2 3 2 N=5	2			
	1050	AUGER		3			
	450	SPT	2 5 4 N=9				
BOX 1	1050	AUGER		4			
	450	SPT	3 4 5 N=9	5			
	1050	AUGER		6			
	450	SPT	2 4 6 N=10				- becomes very light brown, white and black specks, saturated.
	1050	AUGER		7			
BOX 2	150	SPT	3 4 8 N=12	8		MD	- black carbonaceous material for 50mm (1mm thick layers). - becomes orange brown, some silt and tightly packed. - becomes loosely packed, minor silt.
	1050	AUGER		9			- becomes tightly packed, light brown with black carbonaceous specks and streaks, silty. - minor silt, loosely packed.
BOX 3	450	SPT	3 5 9 N=14	10			END OF BOREHOLE AT 10.0m

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH2
Hole Location: GPS mark 40
SHEET ...1... OF ...1...

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 15/5/06
HOLE FINISHED: 15/5/06
DRILLED BY: LDE
LOGGED BY: SJWW
CHECKED: JRL

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION	CORE RECOVERY	METHOD	TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
QUARTERNARY SANDS		AUGER		0	MH	V+	SILT, some fine sand, highly plastic, wet, brown. - becomes light brown orange, very stiff. - twigs.
					SM	L	SAND (fine to medium), some silt, loosely packed, wet, light brown orange brown.
							NO RECOVERY.
				1			
	450	SPT	4 4 5 N=9				
	1050	AUGER		2			
	450	SPT	3 5 5 N=10	3			
BOX 1	1050	AUGER		4			- becomes orange brown.
	450	SPT	4 4 5 N=10				
	1050	AUGER		5		MD	- black carbonaceous material. - becomes saturated.
				6			- black carbonaceous material.
	450	SPT	5 6 8 N=14				
	1050	AUGER			MH	St	SILT, some sand (fine), moderately plastic, firm to stiff, light grey.
				7		S	NO RECOVERY, recovered as silty mud as water filled in the bottom of the hole before run.
BOX 2	450	SPT	3 5 8 N=13		MH	St	SILT, clayey, soft to firm, grey brown, sticky as much water came out with sample (water filling hole).
BOX 3				8			END OF BOREHOLE AT 8.0m - rods jammed. -piezometer installed to 9.0m. -screened.
				9			
				10			

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3
Hole Location: GPS mark 41
SHEET....1..... OF.....1.....

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 16/5/06
HOLE FINISHED: 16/5/06
DRILLED BY: LDE
LOGGED BY: SJWW CHECKED: JRL

GEOLOGICAL GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	CORE RECOVERY	METHOD	TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	STRENGTH/DENSITY CLASSIFICATION	ENGINEERING DESCRIPTION SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL					OL	St	SILT, some sand (fine), organic, roots, dark brown.
QUARTERNARY SANDS		AUGER			SM		SAND (fine), very silty, non plastic, moist to wet, highly packed, grey brown.
				1	MH		SILT, slightly sandy, highly plastic, stiff to very stiff, wet, light brown mottled orange. - firm for 100mm.
	450	SPT	3 3 4 N=7	2		L	SAND (fine to medium), loosely packed, wet, occasional black specs, (carbonaceous material / or weathering), light orange brown.
	1050	AUGER		3			
	450	SPT	4 3 5 N=8				
BOX 1	1050	AUGER		4			
	450	SPT	4 5 7 N=12	5		M-D	
	2050	AUGER		6 7			- becomes saturated.
	450	SPT	5 9 12 N=21				
BOX 2	550	AUGER					- 50mm layer silty, very light grey / brown.
	450	SPT	9 10 9 N=19	8	MH		SILT, sandy (fine), saturated, soft to firm in some parts, SAND is dominant fraction (loosely packed), light brown.
BOX 3	550	AUGER			SM	D	SAND, fine to medium, wet, only just tightly packed, orange brown mottled black.
		SPT	20 for 75mm bouncing so SPT stopped.	9 10			**END OF BOREHOLE AT 9.0m** - rods jammed. -piezometer installed. - 0.0 to 7.0m bentonite seal. - screened 7.0 to 9.0m.

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH4
Hole Location: GPS mark 42
SHEET 1 OF 1

PROJECT: Mangawhai Sewer Plant - Geo
LOCATION: Mangawhai
JOB No: 23428.001

CO-ORDINATES mN
mE
R.L. m
DATUM

DRILL TYPE: GEOPROBE
DRILL METHOD: Percussion
DRILL FLUID: N/A

HOLE STARTED: 16/5/06
HOLE FINISHED: 16/5/06
DRILLED BY: LDE
LOGGED BY: SJWW CHECKED: JRL

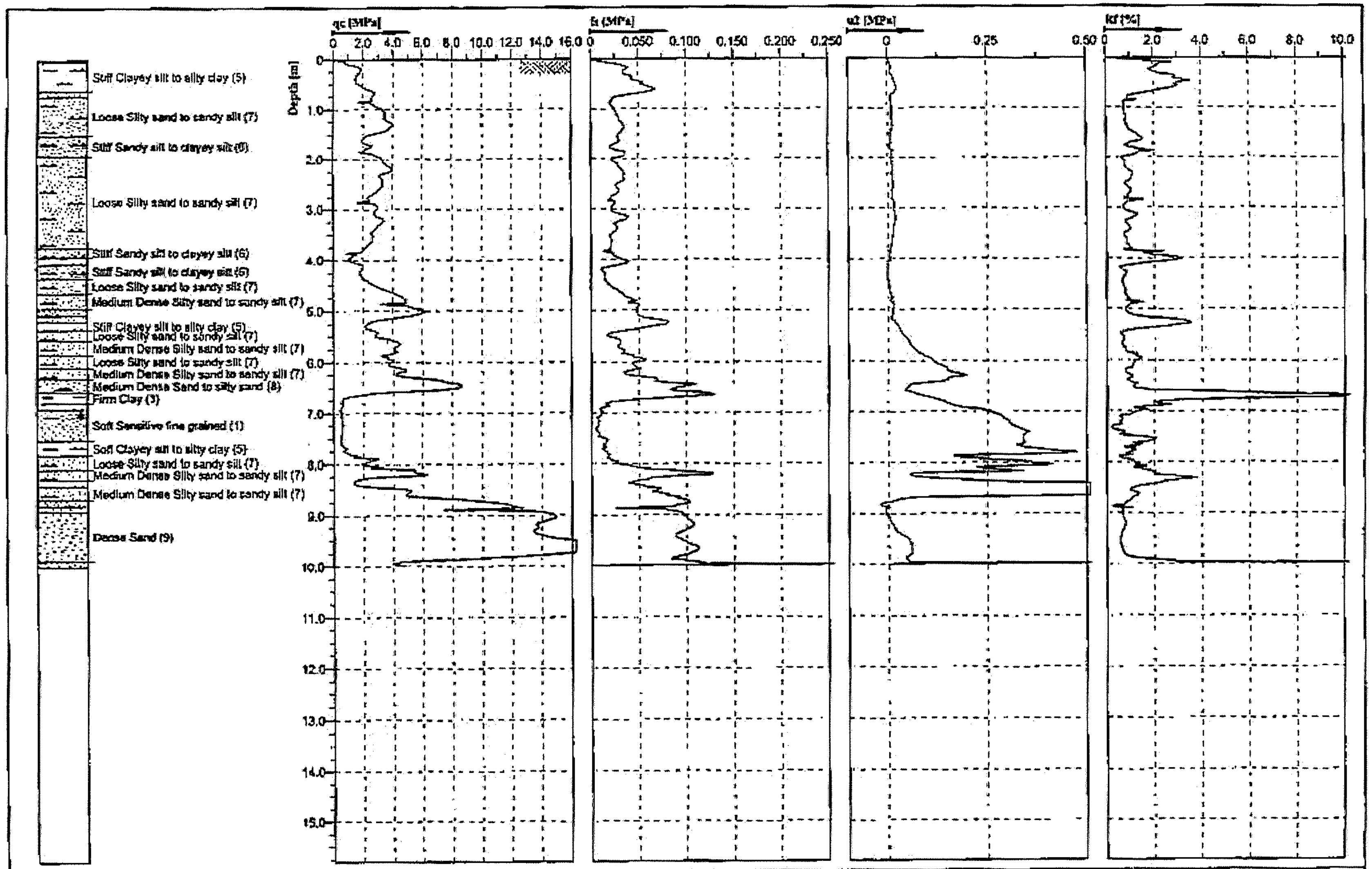
SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

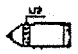
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

GEOLOGICAL Geological unit, generic name, origin, mineral composition	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	ENGINEERING DESCRIPTION
TOPSOIL										OL		F				SILT, sandy, organic, roots, wet, dark brown.
ESTUARINE DEPOSITS				AUGER						MH						SILT, some sand, moderately plastic, wet, form, light brown mottled orange.
										SM						SAND (fine to medium), some silt, loosely packed, light orange brown.
									1	MH		St				SILT, sandy, stiff to very stiff, roots, low to moderately plastic, light brown grey. - becomes clayey, minor sand, very highly plastic, firm to stiff.
			450	SPT		0 1 1 N=2			2							
BOX 1			1050	AUGER					3							- becomes orange brown.
			450	SPT		0 2 3 N=5				SM		L				SAND (fine), crumbly, tightly packed, hard, moist, limonite, orange brown (dark orange).
										SM						SAND (fine to medium), loosely packed to tightly packed orange brown with black fine gravel sized specks.
			1050	AUGER					4	MH						SILT, minor fine sand, wet, stiff, highly plastic, orange brown.
										MH						SILT, hard orange brown with very hard SAND to coarse gravel sized angular orange brown clasts of limonite.
			450	SPT		2 3 6 N=9			5	MH						SILT, clayey, minor fine to coarse rounded sand, (sand green grey and white), very highly plastic, stiff to very stiff, light grey. - coarse gravel very rounded (one).
			1050	AUGER						SM		MD				SAND (fine), silty with some medium to coarse SAND tightly packed. - coarse gravel sized light green grey SILT clast.
BOX 2			[illegible]	SPT		12 30 20 N=50 for 75mm			6			D				- 6.0 to 6.5m orange brown to brown stained layers up to 10mm thick.
			925	AUGER												- saturated.
BOX 3			[illegible]	SPT		20 for 30mm bouncing			7							END OF BOREHOLE 4 AT 7.0m - rods jammed.
									8							
									9							
									10							

APPENDIX B

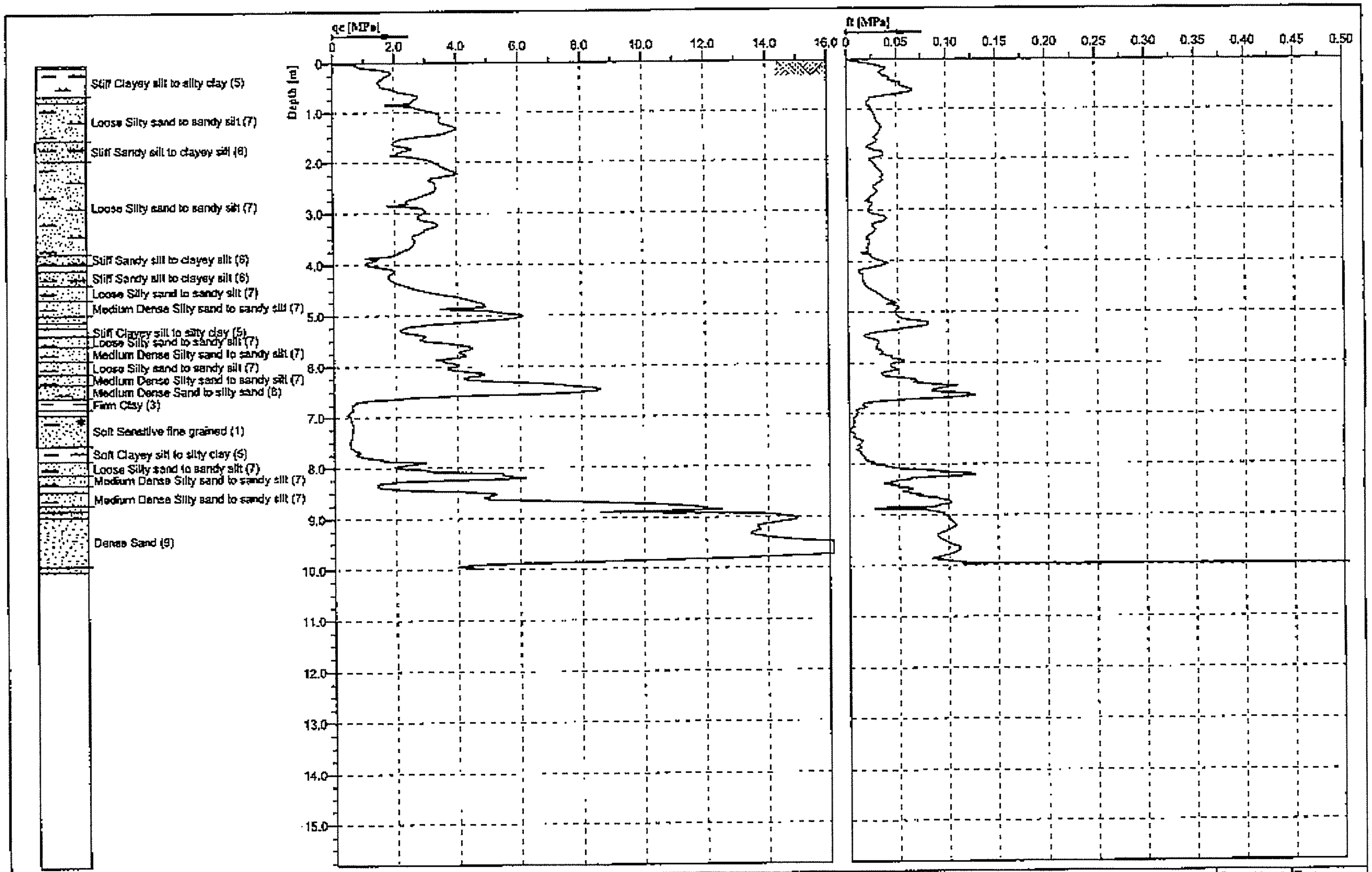
HISTORICAL CPT





Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT1
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2005	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt10.001	



Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location:	MANGAWHAI HEADS	Position:	X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT1
Project ID:	D1131	Client:	TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project:	MANGAWHAI HEADS SEWER PLANT - 23428.001			Page: 1/1	Fig:
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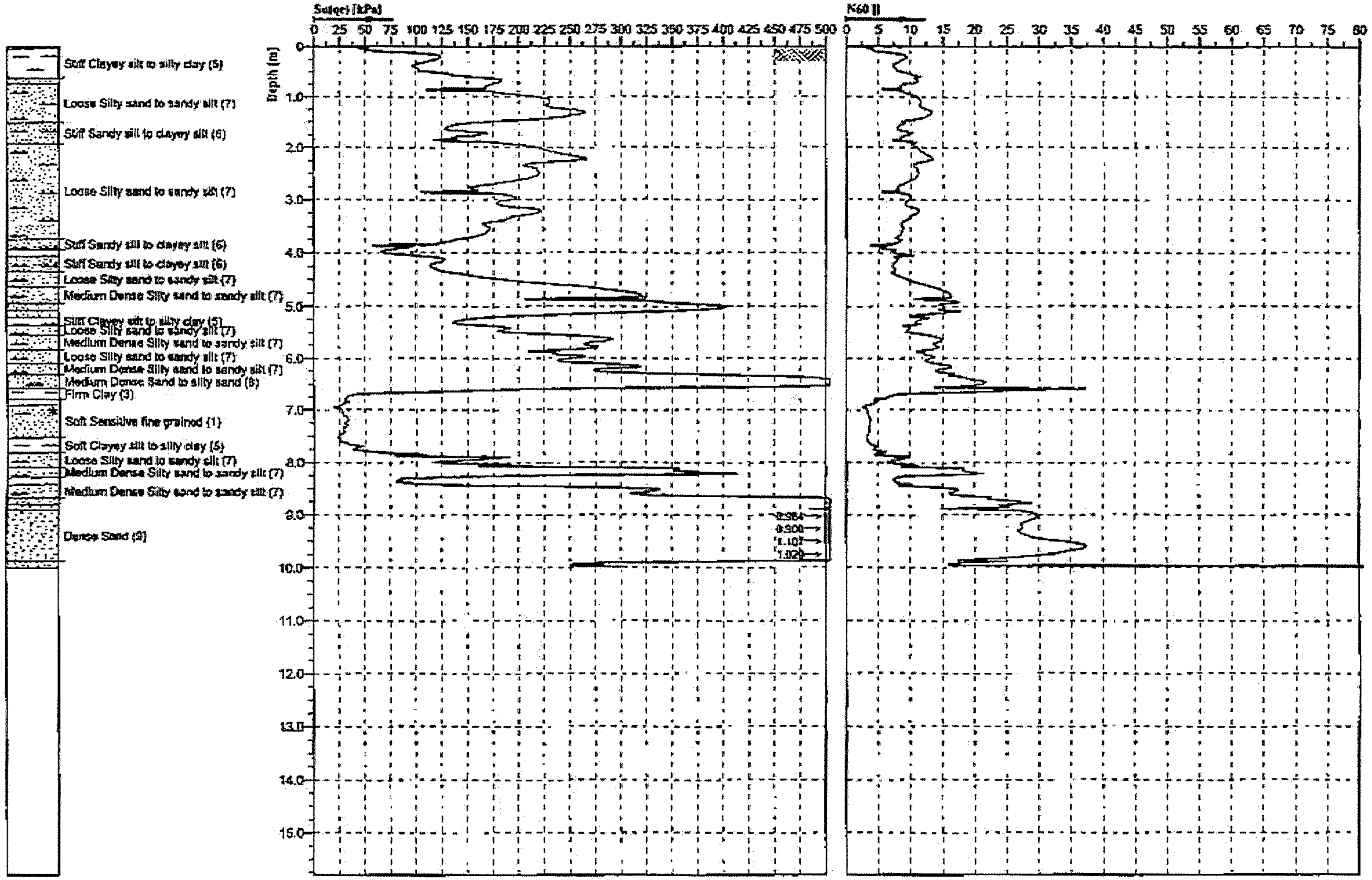

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT1
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
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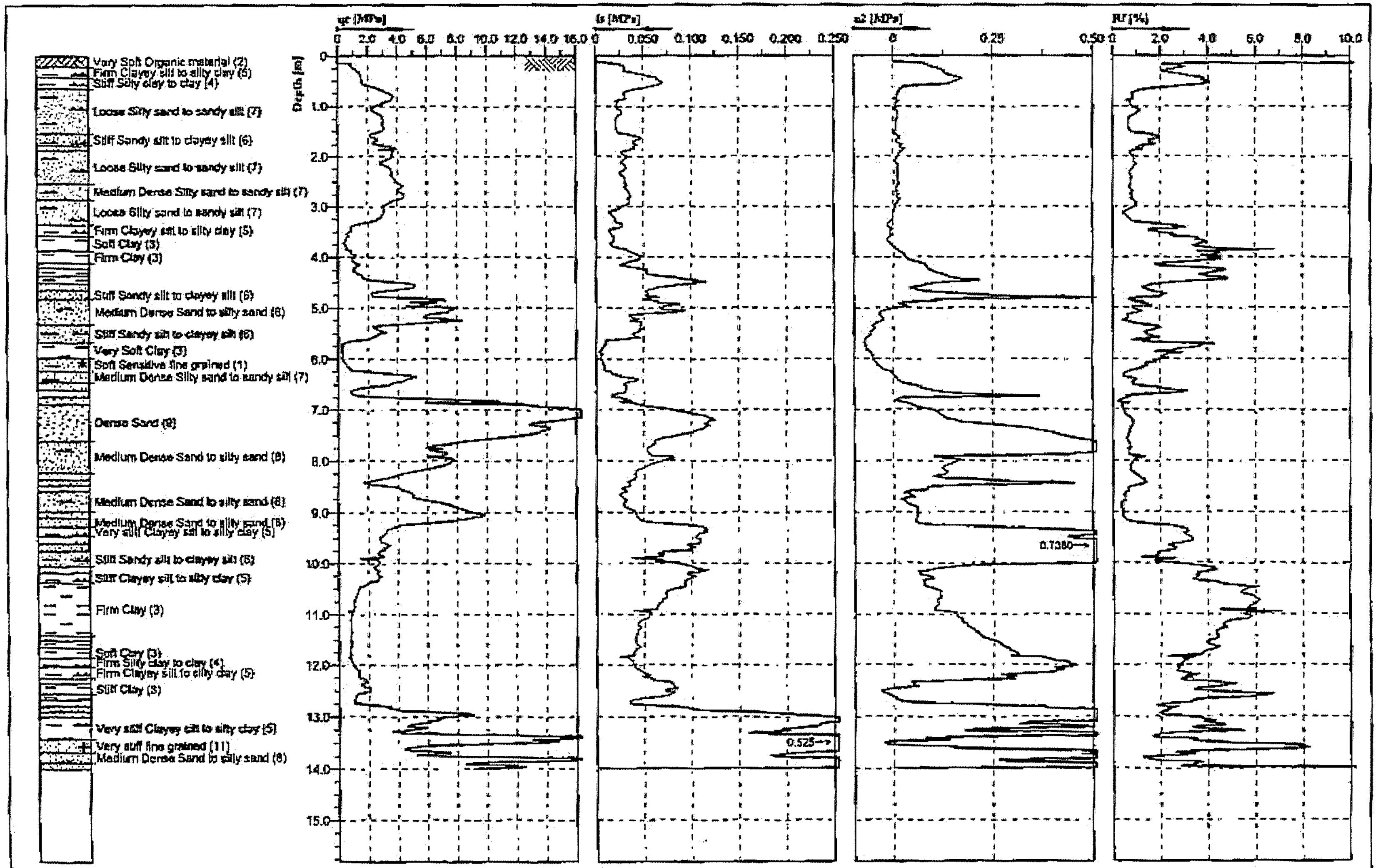

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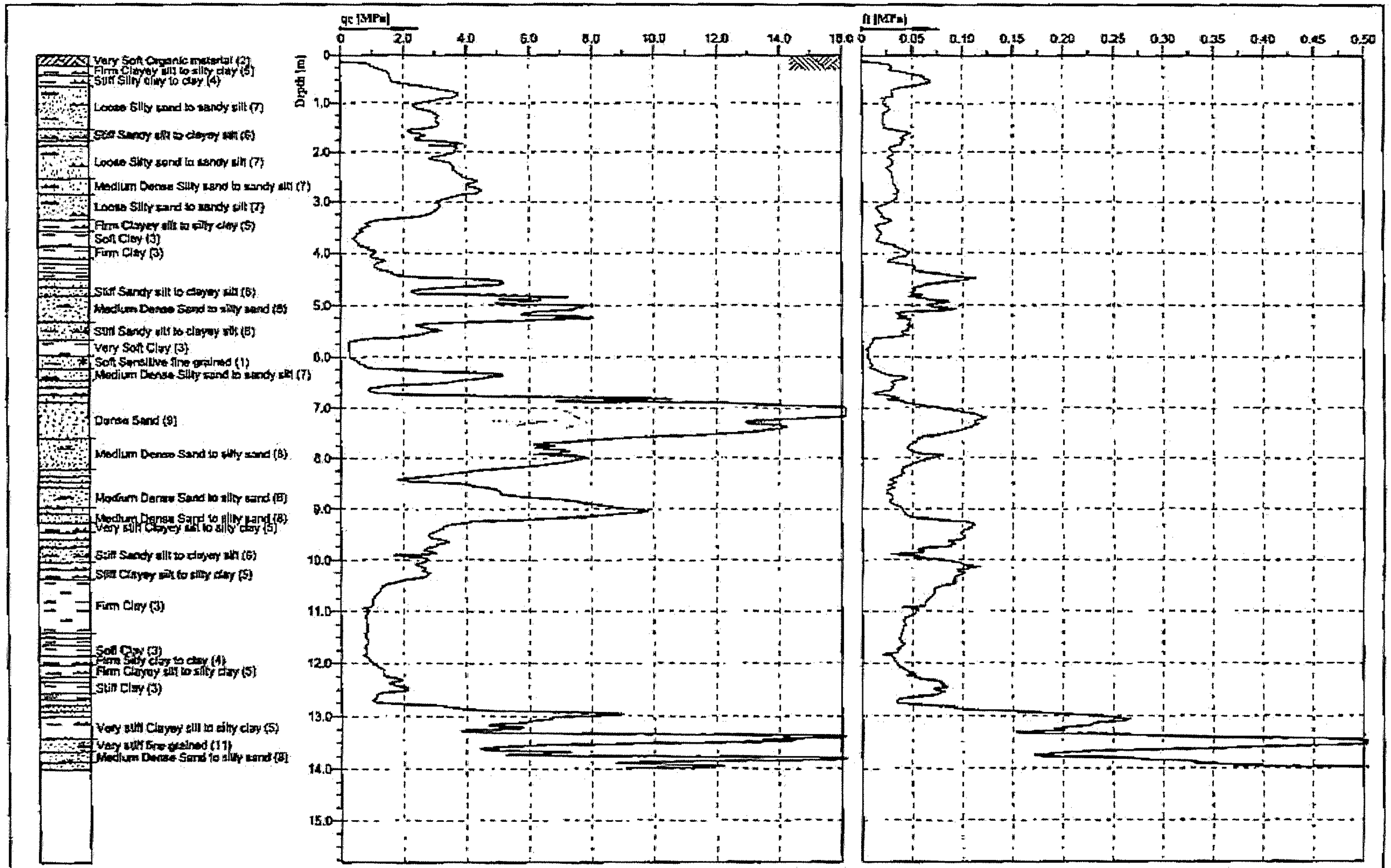
u2

Cone No 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT2
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt2.001	



Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT2
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2008	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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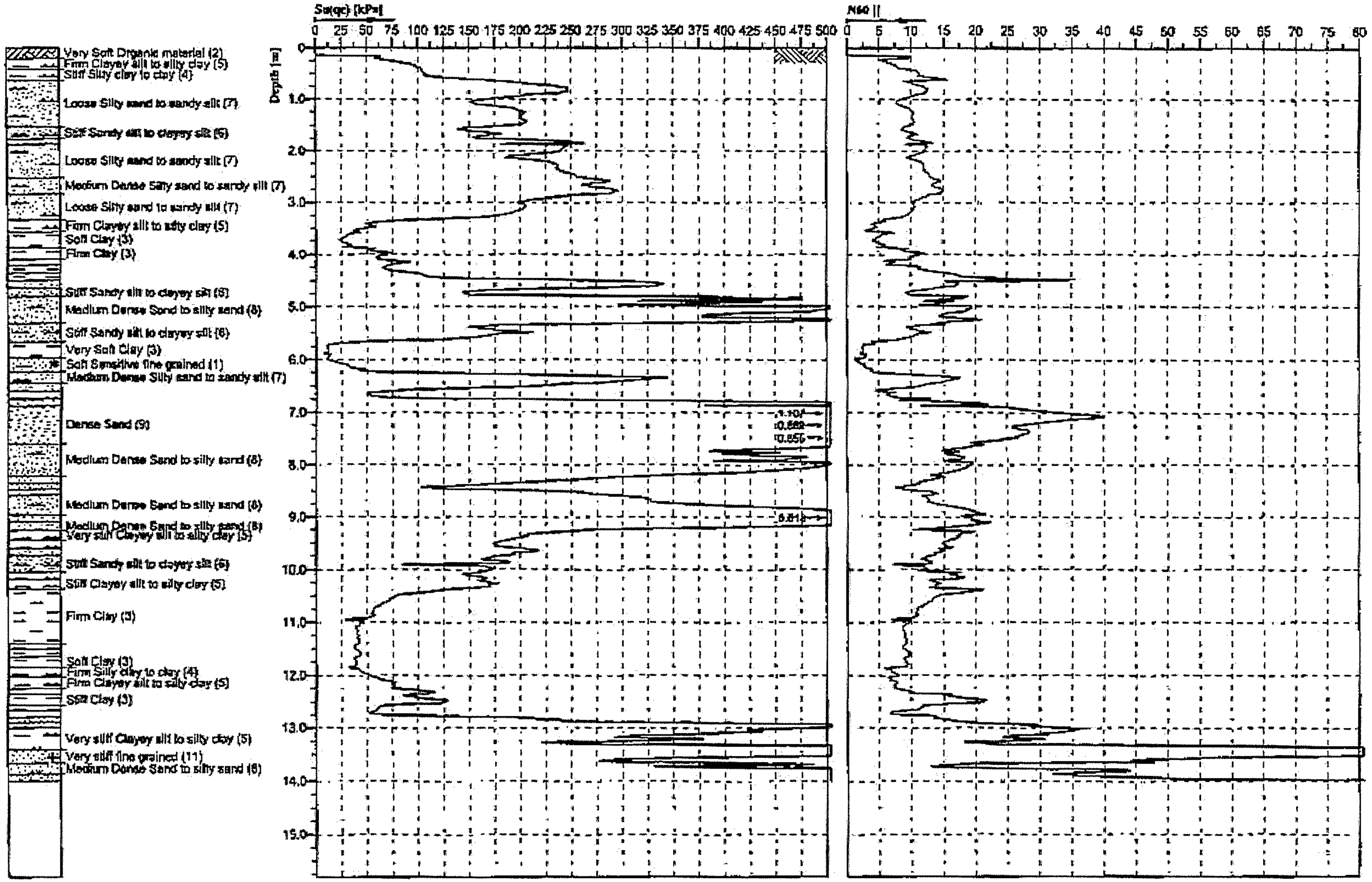

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

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Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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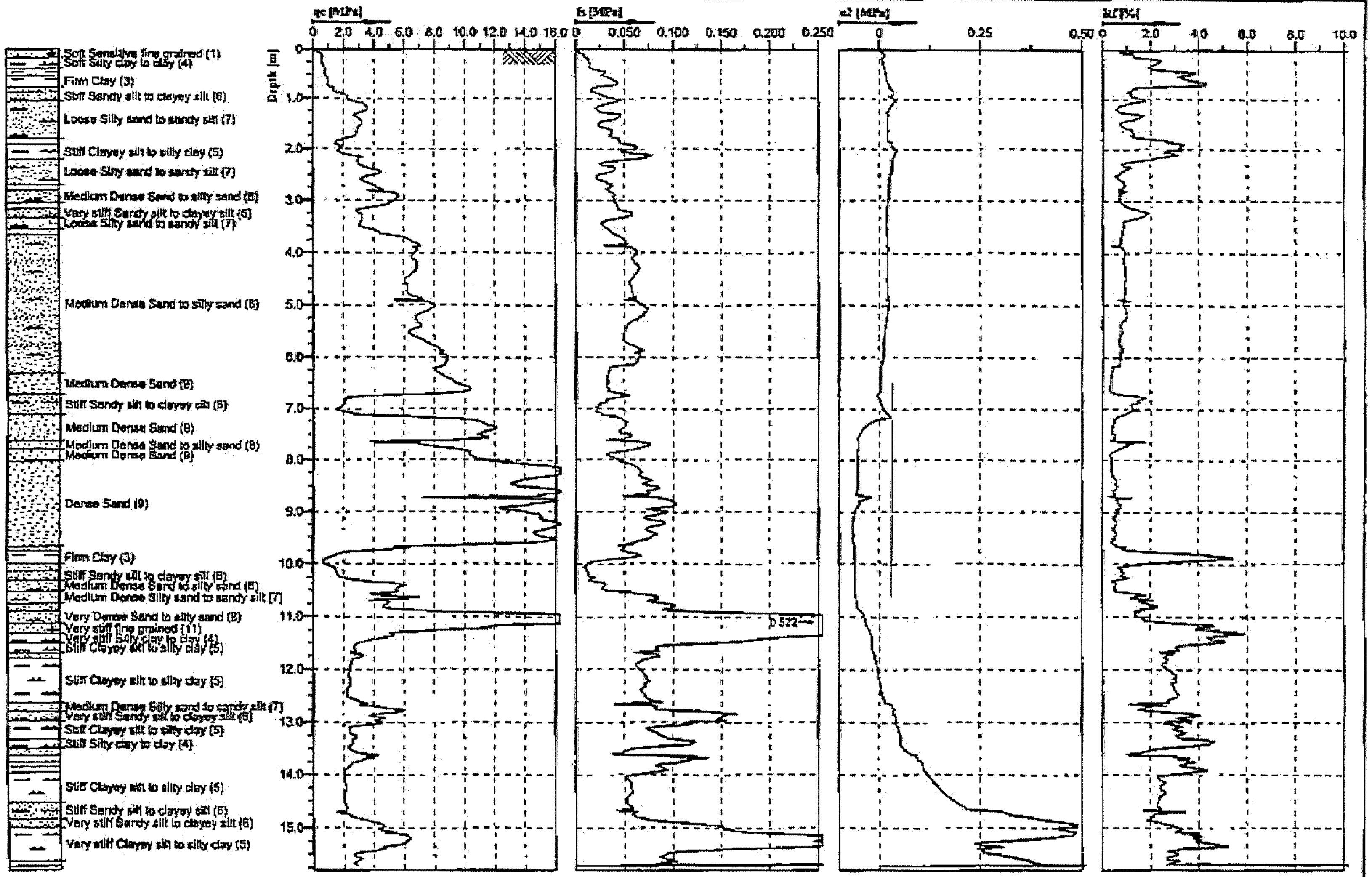

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Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS		Position: X: 0.00 m, Y: 0.00 m		Ground level: 0.00	Test no: CPT3
Project ID: D1131		Client: TONKIN & TAYLOR LTD		Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001				Page: 1/1	Fig:
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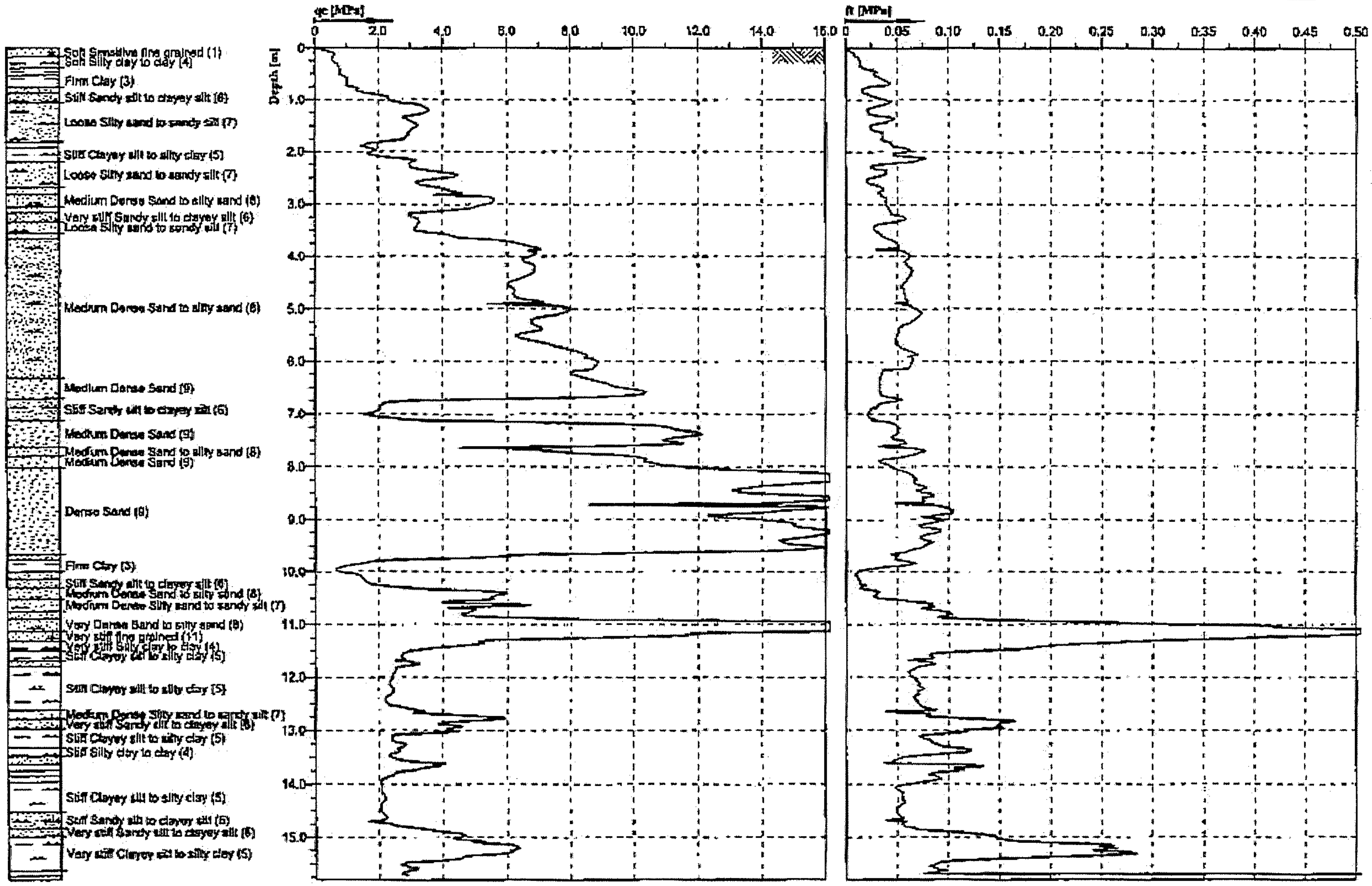

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Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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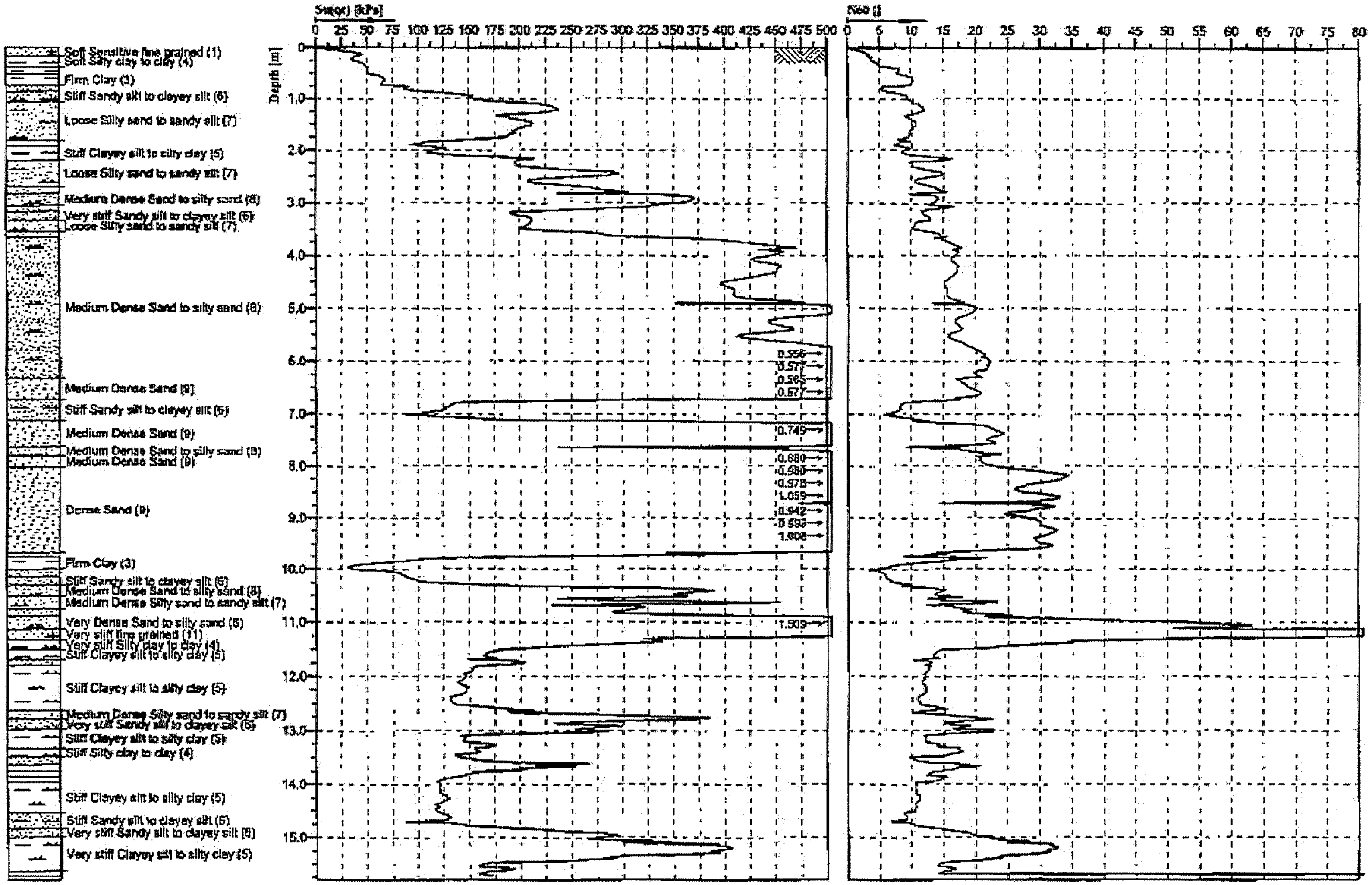

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

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Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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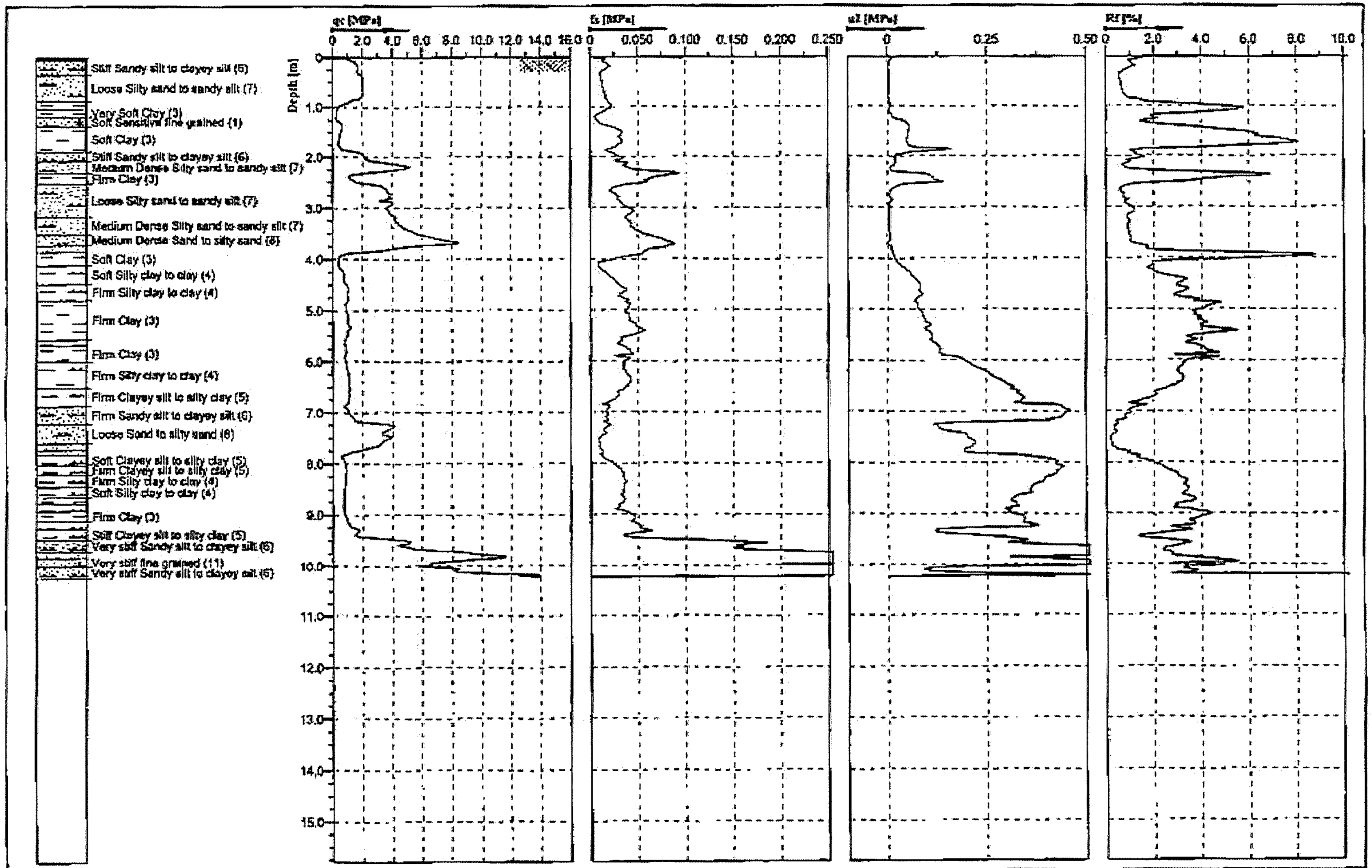

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location:	MANGAWHAI HEADS	Position:	X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT4
Project ID:	D1131	Client:	TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project:	MANGAWHAI HEADS SEWER PLANT - 23428.001			Page: 1/1	Fig:
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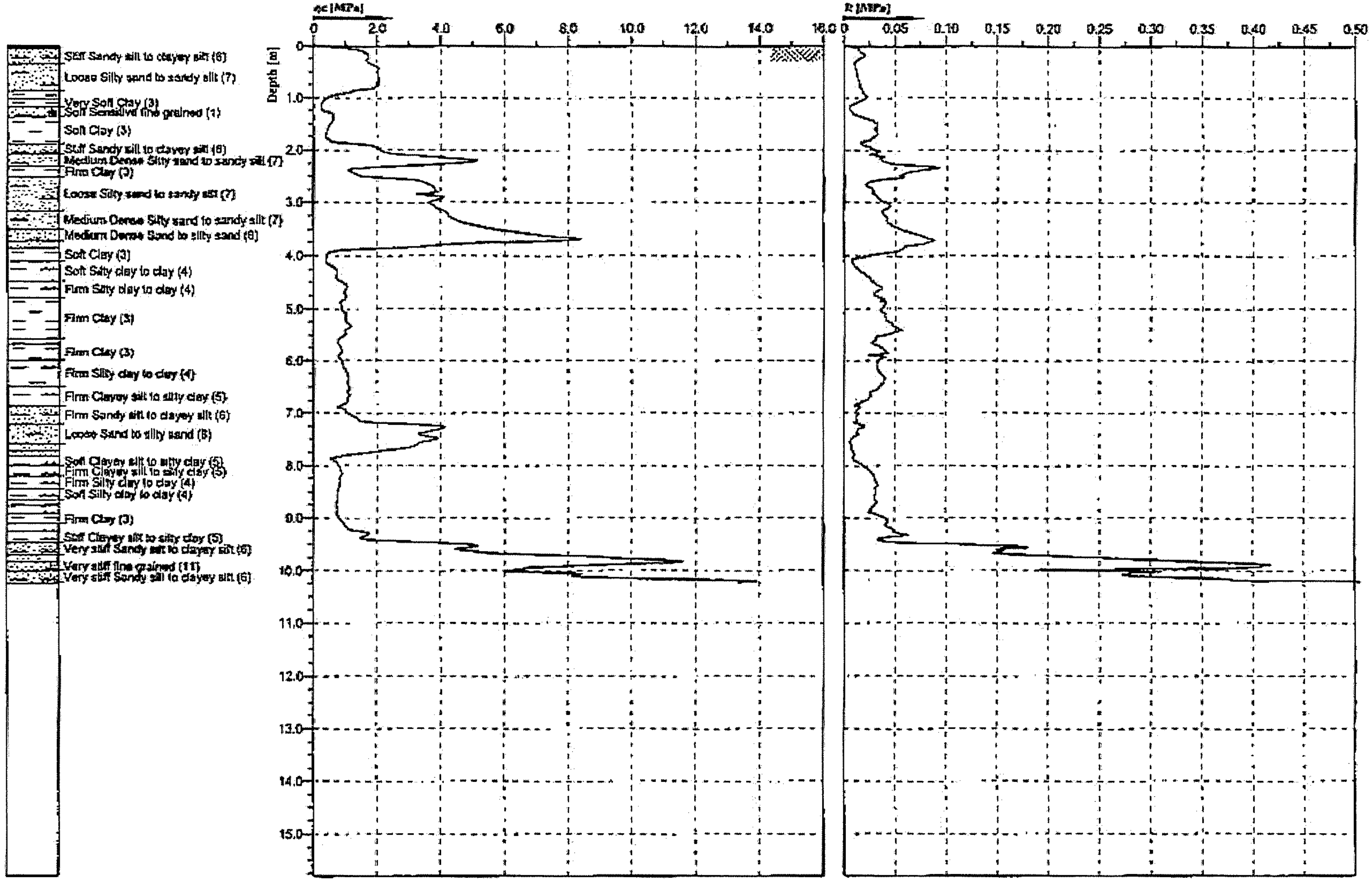

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT4
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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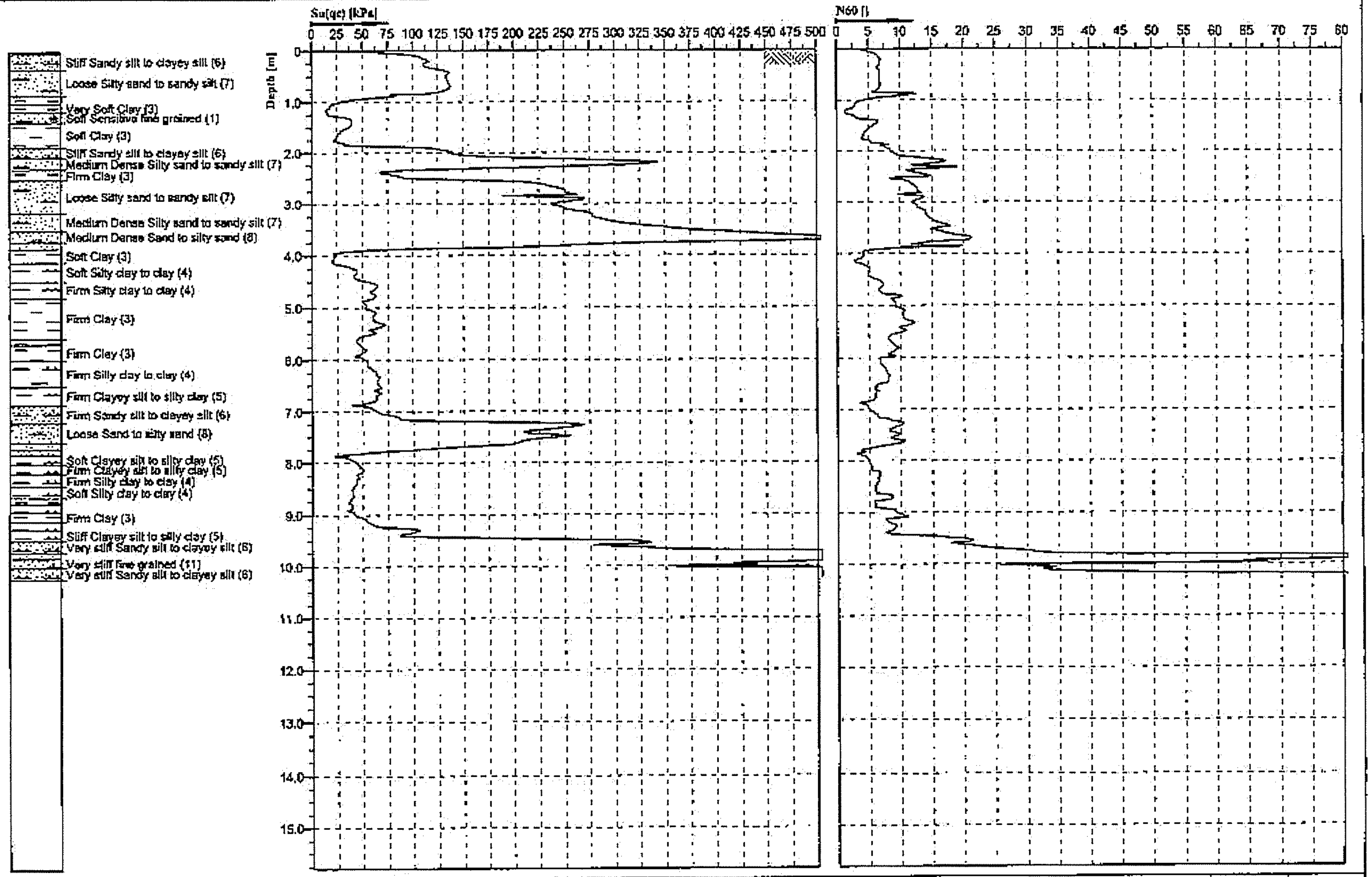
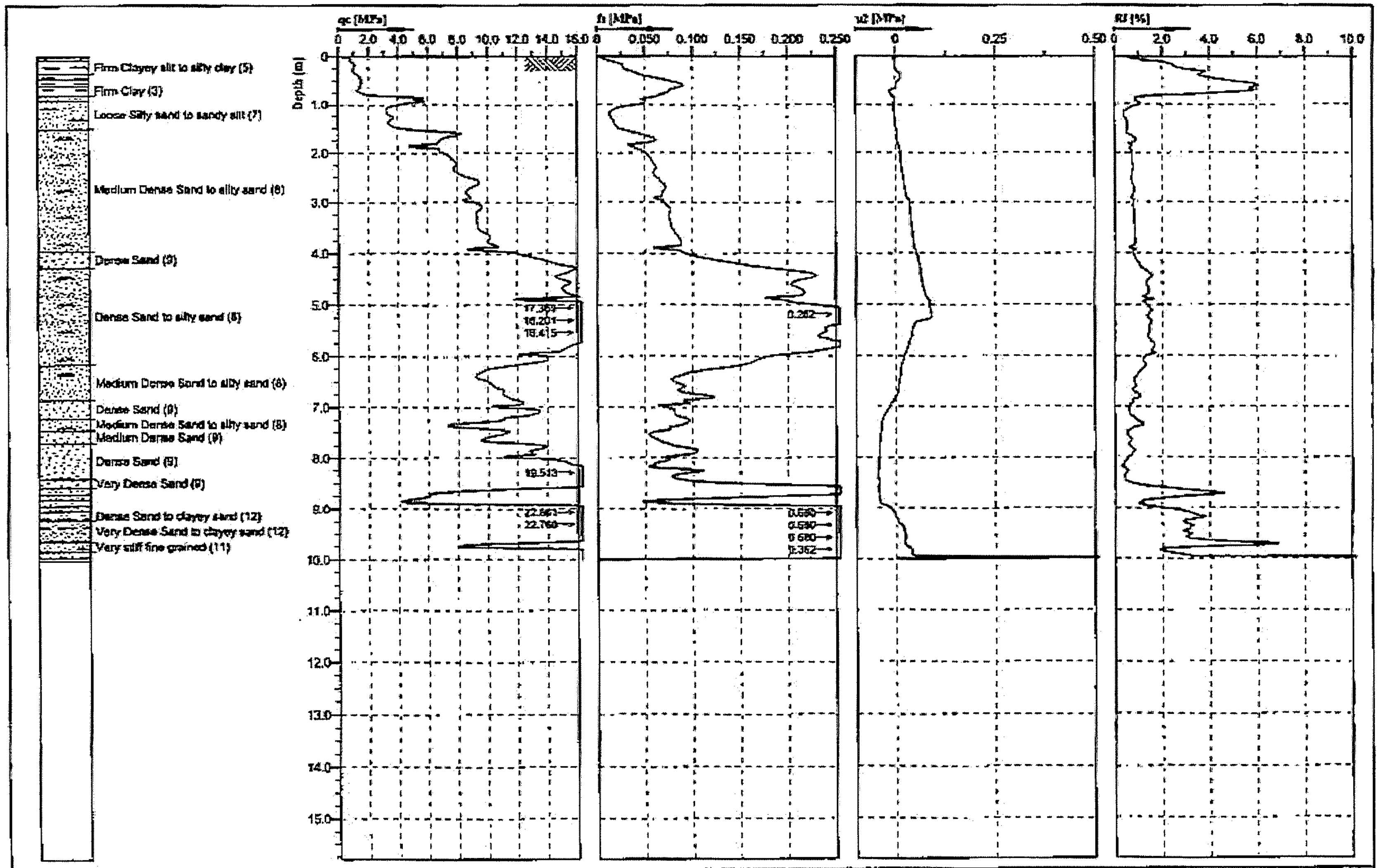


Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT4
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: cpt15.001	



Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT5
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
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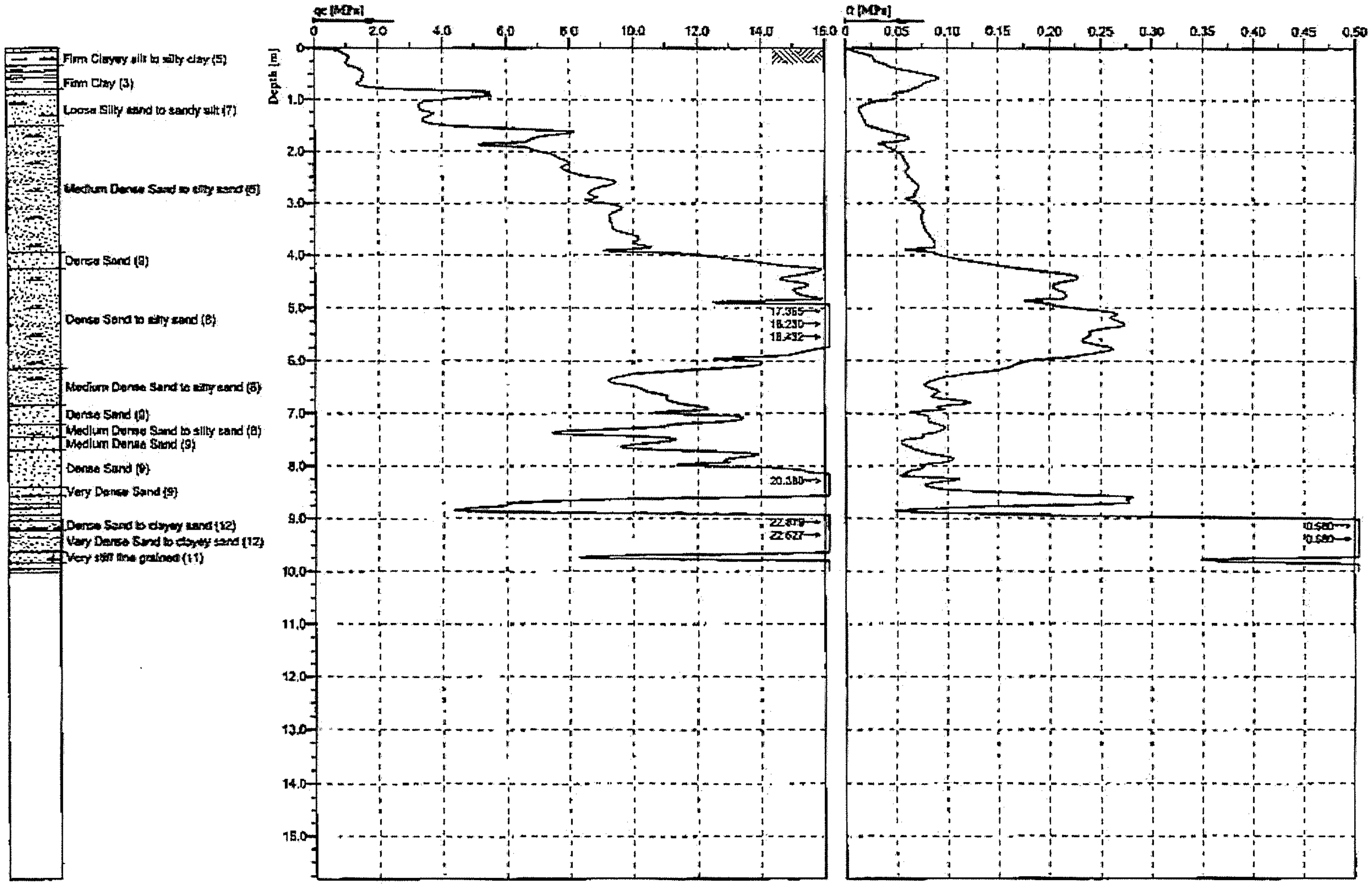

Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS
Position: X: 0.00 m, Y: 0.00 m
Ground level: 0.00
Test no: CPT5
Project ID: D1131
Client: TONKIN & TAYLOR LTD
Date: 17/05/2006
Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001
Page: 1/1
Fig:
File: CPT5.002

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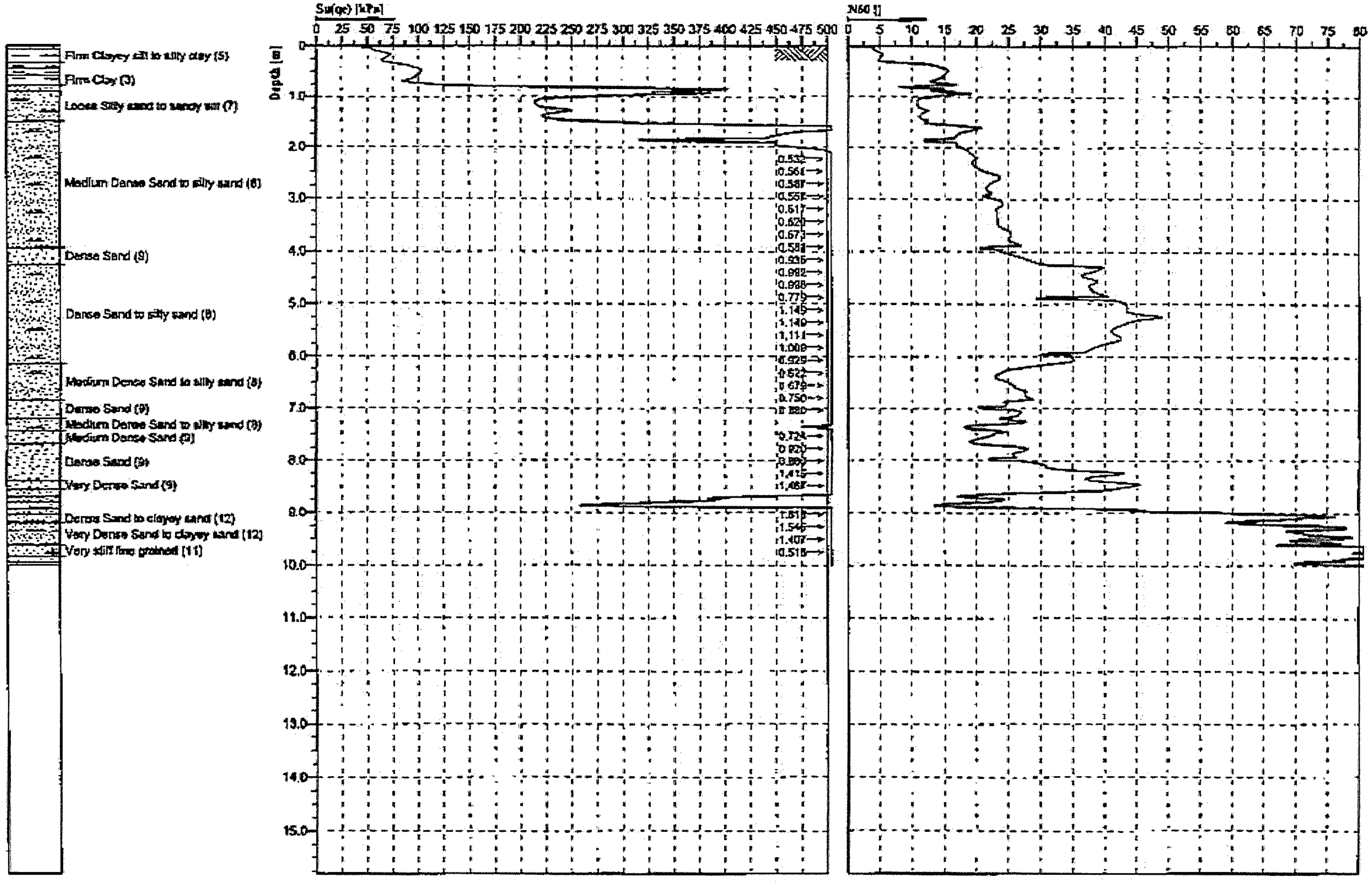

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Cone No: 0
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: MANGAWHAI HEADS	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT5
Project ID: D1131	Client: TONKIN & TAYLOR LTD	Date: 17/05/2006	Scale: 1 : 100
Project: MANGAWHAI HEADS SEWER PLANT - 23428.001		Page: 1/1	Fig:
		File: CPT5.002	

APPENDIX C

NEW CPT LOCATION FOR THE PROPOSED DEVELOPMENTS


CPT 2020/3
CPT 2020/2
CPT 2020/1
CPT 2020/4
Thelma Rd
Thelma Rd
Rd
43
40
● Proposed CPTs Location
🟥 Proposed New Balance Tanks Location

Appendix E
Structural Calculation

CALCULATIONS

PROJECT No / Ref	1-14129.07 / 00001
OFFICE	Christchurch
PROJECT TITLE	Mangawhai CWWTP Balance Tank Concept Design
SUBJECT	Structural Calculations and Sketches
SHEET No	1 OF 31

ISSUE	TOTAL SHEETS	AUTHOR	DATE	CHECKED BY	DATE	APPROVED BY	DATE	COMMENTS
1	31	J. Gale	29/07/20					
2								
3								
4								
5								

SUPERSEDES DOC No

DATE

DESIGN BASIS STATEMENT (Inc. sources of info/data, assumptions made, standards, etc.)

These are the concept design calculations for the Mangawhai CWWTP Balance Tank, Thelma Road, south-west of Mangawhai Heads. The design includes the dimensions of the tank, the initial rebar details, and the thicknesses of the walls.

The calculations were completed using the following: AS/NZS 1170.0-2002, NZS 1170.5-2004, NZS 3106-2009, and NZS 3101-2006.

Calculation assumed:

Soil Class C
Importance Level 3
Design life of 100 years
For concept design stage, effects of swelling and shrinkage neglegable
As tank mostly above ground, earth pressure results neglagable
Unit weight of reinforced concrete of 24 kN/m^3
Unit weight of water of 9.81 kN/m^3
Shear wave velocity as 300 m/s (to be confirmed by geotech investigations)
Half tank area used to determine damping ratio
Strength of concrete as 50 MPa
Strength of steel as 500 MPa
Used crack widths using 3101 method
Walls 4-5 assumed to be two-way spanning

Project Manager's Signature

Name		Signature		Date	

Project Director's Signature

Name		Signature		Date	

JLATION SHEET

c/Task/File No: 1-13586.00 /

ect Description: Mangawhai Balance Tank - Concept Design

Sheet No 1 of

Office: CHCH

Computed: 20 / 07 / 20

Check: / /

Balance tank in Mangawhai Wastewater Treatment Plant on Thelma Road south west of Mangawhr Heads

As in Whangarei region $Z = 0.1$, Soil Class C, IL 3, Design life = 100 yrs (all to be confirmed w/ client)

$\Rightarrow$ APE: ULS earthquake = $1/2500$ $\Rightarrow R_u = 1.8$

SLS = $1/25$ $\Rightarrow R_s = 0.25$

Load case to start with from NZS 3106-2009

SLS (walls): Case 6: full tank = $G + F_{ep} + \cancel{F_e} + \cancel{F_{gw}} + \cancel{F_p} + (E_{s1} \text{ or } E_{s2})$

Case 2: $G + F_{ep} + \cancel{F_p} + \cancel{0.5 F_{sw}}$

ULS (walls): Case 10: $1.2G + 1.2 F_{eb}$

Case 13: $G + E_u + F_{eb}$

Working with Liquid tightness class 1

Note: As this is only a concept design the following effects will not be included in the assessment:

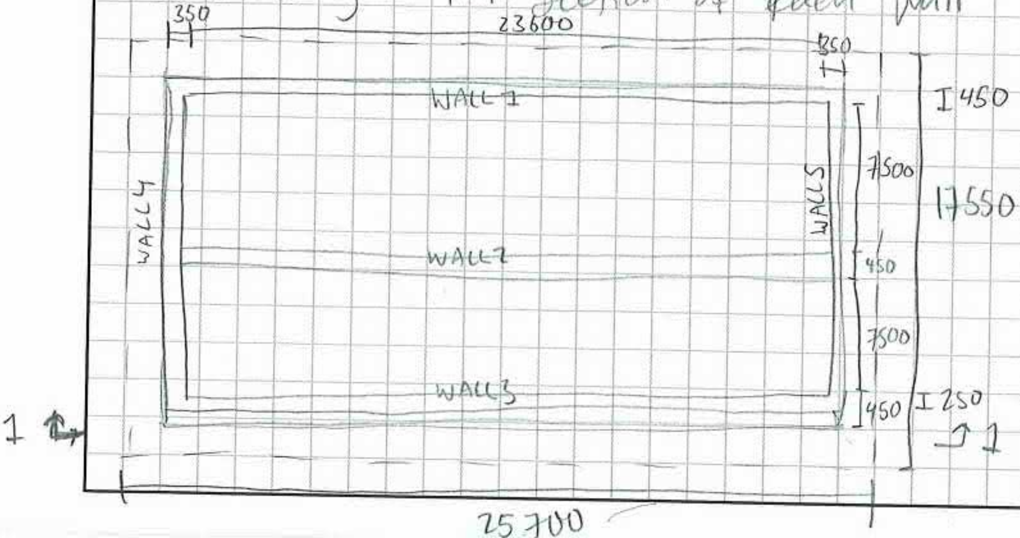
Swelling (F_{sw}), shrinkage (F_{sh}) $\Rightarrow 0$

Assuming earth pressure forces are neglegable as tank on top of soil. $\Rightarrow F_e = 0$
$\Rightarrow F_{gw} = 0$

No prestressing $\Rightarrow F_p = 0$

Currently neglecting baffle walls, only considering outer walls and central dividing wall.

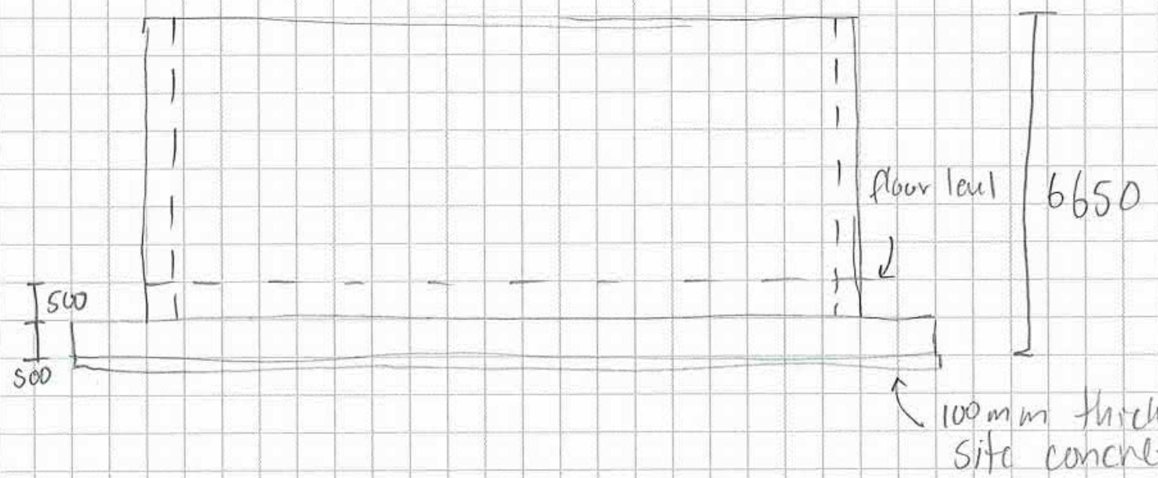
Considering a 1m section of each wall



CALCULATION SHEET

Project/Task/File No: 1-13586.00/
Project Description: Mangawhai Balance Tank – Concept Design – Loading
Sheet No 3 of
Office: CHCH
Computed: 20 / 07 / 20
Check: / /

Elevation 1-1



→ Three walls to check, Walls 1&2 (450 thick), Wall 3 (tapered) (450 - 250 thick), Wall 4&5 (350)

Walls 1&3 reinforcing = Horizontal: at centre = HD20 - 175 w/ 800 lap (FF)
all the way through = HD16 - 175 EF

Vertical HD16 - 175 EF + two laps ① HD25 w HD20 - 150 FF
② HD16 - 150 NF

Wall 2 = horizontal HD16 - 175 EF, Vertical w/ lap HD25 w HD20 - 150 EF

Wall 5 = Horizontal laps HD20&HD16 - 175 20's top & 16's bottom FF
w 800 mm lap

NF = HD16's - 175

Vertical = HD16 - 150 EF

Wall 4 = Same as wall 5 but w/ HD16 traces.

CALCULATION SHEET

Project/Task/File No: 1-13586.00/ Sheet No 4 of

Project Description: Mangawhai Balance Tank - Concept Design - loadings Office: CHCH

Computed: 20/07/20

Check: / /

Dead Loads

Wall 1 & 2 1m x 0.45 m x 24 kN/m^3 = 10.8 kPa

Wall 3 @ TOP: 0.25 m x 24 kN/m^3 = 6 kPa

@ BOTTOM: 0.45m x 24kN/m^3 = 10.8 kPa

Wall 4 & 5 = 1m x 6.15m x 0.35 x 24 kN/m^3 = 8.4 kPa

Liquid pressure Max = 9.81 kN/m^3 x 6.15m = 60.33 kPa

Earthquake, wall and water

Base shear $C(T_1) = C_h(T_i)\, Z R N(T_1, D)$

Ground supported rectangular tank vertical & horizontal $\Rightarrow \Phi_i = 0.1$

$\Rightarrow C_h(T_i) = 2.36$, $Z = 0.1$, $R_s = 0.25$, $R_u = 1.3$

$N(T,D) = 1$

$\Rightarrow$ SLS $= 2.36 \times 0.1 \times 0.25 \times 1 = 0.059$

$\Rightarrow$ ULS $= 2.36 \times 0.1 \times 1.8 \times 1 = 0.425$

$C_d(T_1) = C(T_i)\, k_f(\mu, \xi_1)\, S_p$ S_p :

Shear wave velocity to be confirmed by geotech info.

For horizontal impulsive ULS loads $\mu = 1.25$
For horizontal impulsive SLS loads $\mu = 1$
Vertical impulsive ULS = 1.25
Vertical impulsive SLS = 1
Convectia, all = 1

Assuming shear wave velocity in soil = 300 m/s

Note to be confirmed by geotech investigation

Need H/a where H = tank height, a = radius of circular tank

for rectangular tank find equivalent tank radius w/ same plan area.

CALCULATION SHEET

Project/Task/File No: 1-13586.001
Project Description: Mangawhai Balance Tank - Concept Design - Loading
Sheet No 5 of
Office: CHCH
Computed: 21 / 07 / 20
Check: / /

Option ① considering whole tank area $= 16.35 \, m \times 24.3 \, m$
$= 397.31 \, m^2$

$A = \pi r^2 \Rightarrow r = \sqrt{\frac{A}{\pi}}$

$\Rightarrow a = \sqrt{\frac{397.31}{\pi}}$

$= 11.25 \, m$

$= H/a = 6.65 / 11.25 = 0.59 \hat{=} 0.5$

$\Rightarrow$ damping ratio % = 18% horizontal impulsive
= 10% vertical impulsive

Option ② half tank area $= 198.66 \, m^2$

$\Rightarrow a = \sqrt{\frac{198.66}{\pi}} = 7.95 \, m$

$\Rightarrow H/a = 6.65 / 7.95 = 0.84 \hat{=} 0.8$

$\Rightarrow$ damping ratio % = 15% horizontal impulsive
= 12% vertical impulsive

Both options convective = 0.5%

More conservative to use smaller damping ratio
$\Rightarrow$ use the smallest in each case
$\Rightarrow$ horizontal impulsive = 15%
$\Rightarrow$ vertical impulsive = 10%

Can I use smallest from each or choose one?

use option 2

$\Rightarrow \underline{k_f(\mu, \xi_i)}$

- convective, horizontal & vertical = 1.67

CALCULATION SHEET

Project/Task/File No: 1-13586.01 /
Project Description: Mangawhai Balance Tank - Concept Design - Loading
Sheet No 6 of
Office: CHCH
Computed: 21 / 07 / 20
Check: / /

- impulsive horizontal SLS = 0.64
- impulsive horizontal ULS = 0.58
- impulsive vertical SLS = 0.76
- impulsive vertical ULS = 0.67.

$\underline{C_d(T_i)}$

- convective SLS = 0.059 × 1.67 = 0.099
- convective ULS = 0.425 × 1.67 = 0.710
- impulsive horizontal SLS = 0.059 × 0.64 = 0.038
- impulsive horizontal ULS = 0.425 × 0.58 = 0.247
- impulsive vertical SLS = 0.059 × 0.76 = 0.045
- impulsive vertical ULS = 0.425 × 0.67 = 0.285

$V_H = C_d(T_i) W_i$ where W_i = equivalent weight of tank & contents responding in particular mode of vibration considered. (i.e. T = 0.1 impulsive

$\underline{T_c}$ depends on l/H l = ½ length of rectangular tank in direction being considered

$\Rightarrow l_x = \frac{1}{2} \times 24.3m = 12.15m \quad \Rightarrow \frac{l_x}{H} = \frac{12.15}{6.65} = 1.83$

$\Rightarrow l_y = \frac{1}{2} \times 16.35m = 8.18m \quad \Rightarrow \frac{l_y}{H} = \frac{8.18}{6.65} = 1.23.$

$\sqrt{\frac{g}{l_x}} = \sqrt{\frac{9.81}{12.15}} = 0.899 \qquad \sqrt{\frac{g}{l_y}} = \sqrt{\frac{9.81}{8.18}} = 1.095$

$\Rightarrow T_{cx} = 6/0.899 = 6.67$

$\Rightarrow T_{cy} = 5.5/1.095 = 5.02$ } ? use

does this T_c get used for determination of $C(T_i)$ at the beginning?
=> do I need to update?
yes

CALCULATION SHEET

Project/Task/File No: 1-13586.01/
Project Description: Mangawhai Balance Tank - Concept Design - Loading
Sheet No 7 of
Office: CHCH
Computed: 21 /07 /20
Check: / /

W $\frac{l_x}{H} = 1.83$ $\frac{l_y}{H} = 1.23$

W_L = weight of liquid.
to be conservative assume whole tank? (kN)

$\Rightarrow \frac{W_i}{W_L} = 0.33$ $W_L = 9.81\,kN/m^3 \times 397.31m^2 \times 6.65\,m$
$= 25.92\,kN$

$\Rightarrow \underline{W_i = 8.55\,kN}$

$\frac{h_i}{H} = 0.39 \Rightarrow h_i = 2.59\,m$

$\frac{h_c}{H} = 0.54 \Rightarrow h_c = 3.59\,m$

$\frac{W_c}{W_L} = 0.68 \Rightarrow \underline{W_c = 17.63\,kN}$

↑ x direction
↓ y direction

V_H

- $\frac{h_i}{H} = 0.39 \Rightarrow h_i = 2.59\,m$
- $\frac{W_i}{W_L} = 0.45 \Rightarrow \underline{W_i = 11.66\,kN}$
- $\frac{W_c}{W_L} = 0.54 \Rightarrow \underline{W_c = 14.00\,kN}$
- $\frac{h_c}{H} = 0.57 \Rightarrow h_c = 3.79\,m$

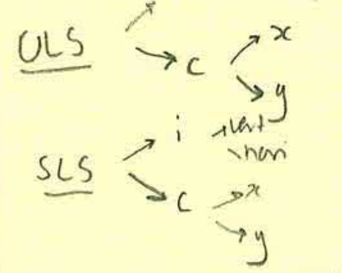
V_H

-

From this point on decided to move to a spreadsheet to enable me to keep track of the numbers easier.

$$y = \left[\frac{y_2 - y_1}{x_2 - x_1}\right]\left[x - x_1\right] + y_1$$

y = in box
x = ξ



Sheet 8
Date 27/07/2020

Project Title	Mangawhai CWWTP Balance Tank Concept Design
Project Number	1-14129.07 / 00001
Location	Neer Mangawhai Heads, Whangarei
Author	Jess Gale

Earthquake Elastic Site Spectra, C(T)			
Hazard Factor	**Z**	0.1	
Soil Class		C	
IL		3	
Design Life		100	years
APE (ULS)		1/2500	
APE (SLS)		1/25	
Return period factor (ULS)	**R_u**	1.8	
Return period factor (SLS)	**Rs**	0.25	
Near Fault Factor	**N(T,D)**	1	
Impulsive period	**T_i**	0.1	
$T_c\surd g/l_x$ (Figure A3)		6	
$T_c\surd g/l_y$ (Figure A3)		5.5	
Convective period, x-direcion	**$T_{c,x}$**	6.68	=Tc_sqrt_g_div_lx/(SQRT(g/lx))
Convective period, y-direcion	**$T_{c,y}$**	5.02	=Tc_sqrt_g_div_ly/(SQRT(g/ly))
Spectoral Shape Factor, impulsive	**$C_h(T_i)$**	2.36	
convective, x-direction	**$C_h(T_{c,x})$**	0.09	=3.96/(Convective_period_x^2)
convective, y-direction	**$C_h(T_{c,y})$**	0.16	=3.96/(convective_period_y^2)
Earthquake Elastic Site Spectra (ULS)	**$C(T_i)_{ULS}$**	0.425	=Ch_Ti*Z*Ru*N_T_D
	$C(T_{c,x})_{ULS}$	0.016	=Ch_Tc__x*Z*Ru*N_T_D
	$C(T_{c,y})_{ULS}$	0.028	=Ch_Tc__y*Z*Ru*N_T_D
Earthquake Elastic Site Spectra (SLS)	**$C(T_i)_{SLS}$**	0.059	=Ch_Ti*Z*Rs*N_T_D
	$C(T_{c,x})_{SLS}$	0.002	=Ch_Tc__x*Z*Rs*N_T_D
	$C(T_{c,y})_{SLS}$	0.004	=Ch_Tc__y*Z*Rs*N_T_D

Sheet 9
Date: 27/07/20

Horizontal Design Action Coefficient, $C_d(T)$				
Structural Performance Factor	S_p	1		
Ductility Factor	$\mu_{ULS, i}$	1.25		
	$\mu_{SLS, i}$	1		
	μ_c	1		
Soil shear wave velocity		300	m/s	
Equivalent radius of circular tank	a	7.51	m	=SQRT(area_int/PI())
Height to radius ratio	H/a	0.67		
Damping ratio %	$\xi_{i, horiz}$	17		
	$\xi_{i, vert}$	12		
	ξ_c	0.5		
Correction Factor	$k_f(\mu_c , \xi_c)$	1.67		
	$k_f(\mu_{i, ULS} , \xi_{i, horiz})$	0.56		
	$k_f(\mu_{i, ULS} , \xi_{i, vert})$	0.63		
	$k_f(\mu_{i, SLS} , \xi_{i, horiz})$	0.61		
	$k_f(\mu_{i, SLS} , \xi_{i, vert})$	0.71		
Horizontal Design Action Coefficient, ULS	$C_d(T_{i, horiz})$	0.24		
=C(T)*kf(μ,ξ)*Sp	$C_d(T_{i, vert})$	0.27		
	$C_d(T_{c, x})$	0.03		
	$C_d(T_{c, y})$	0.05		
Horizontal Design Action Coefficient, SLS	$C_d(T_{i, horiz})$	0.04		
	$C_d(T_{i, vert})$	0.04		
	$C_d(T_{c, x})$	0.00		
	$C_d(T_{c, y})$	0.01		

ξ, μ=1.25	10	15	20
k_f	0.67	0.58	0.52
	0.76	0.64	0.56

Sheet 10
Date 27/07/20

Equivalent Hydrodynamic Weights and centers of gravity					
Total weight of liquid (half tank)	W_L	4341 kN			
From Figure A4					
x direction	W_{cx}/W_L	0.73	W_{cx}	423	kN/m
	h_{cx}/H	0.53	h_{cx}	2.65	m
	h_{Ix}/H	0.38	h_{Ix}	1.90	m
	W_{Ix}/W_L	0.26	W_{Ix}	150	kN/m
y direction	W_{cy}/W_L	0.62	W_{cy}	114	kN/m
	h_{cy}/H	0.55	h_{cy}	2.75	m
	h_{Iy}/H	0.37	h_{Iy}	1.85	m
	W_{Iy}/W_L	0.36	W_{Iy}	66	kN/m

Base Shear, V_H	
ULS	
$V_{H, i, horiz, x}$	35.54 kN
$V_{H, i, vert, x}$	40.53 kN
$V_{H, i, horiz, y}$	15.64 kN
$V_{H, i, vert, y}$	17.83 kN
$V_{H, c, x}$	11.28 kN
$V_{H, c, y}$	5.39 kN
SLS	
$V_{H, i, horiz, x}$	5.40 kN
$V_{H, i, vert, x}$	6.32 kN
$V_{H, i, horiz, y}$	2.38 kN
$V_{H, i, vert, y}$	2.78 kN
$V_{H, c, x}$	1.57 kN
$V_{H, c, y}$	0.75 kN

Wtcx	49.86	kPa
Wbcx	34.65	kPa
Wtix	4.21	kPa
Wbix	25.88	kPa
Wtcy	14.83	kPa
Wbcy	7.98	kPa
Wtiy	1.46	kPa
Wbiy	11.79	kPa

Sheet 11.1
Date: 27/07/20

Tank Dimensions			
Height of liquid	H	5	m
Tank length	in x	24.3	m
	in y	16.35	m
Half tank length, l	in x	12.15	m
	in y	8.175	m
Internal Tank length for one section	in x	23.6	m
	in y	7.5	m
Tank Ratios	l_x/H	2.43	
	l_y/H	1.635	
Tank internal area	one section	177	m^2
Wall Thickness			
Wall 1 & 2		0.45	m
Wall 3 (max)		0.45	m
Wall 3 (min)		0.25	m
Wall 4 & 5		0.35	m
Height to c.o.g of wall		2.5	m
Material Unit Weights			
Gravity force	g	9.81	kN/m^3
Weight of water		9.81	kN/m^3
Weight of RC		24	kN/m^3

Sheet 12
Date: 27/07/20

Horizontal siesmic shear, V_H	=SQRT(((Cd_Ti__horiz*(Wlx+Ww_1_2))^2)+((Cd_Tc__x*Wcx)^2))		
W_w	Walls 1, 2 &3	Wall 4 & 5	
Tank wall weight (per m section)	54	42	kN/m
	ULS		
$V_{H, horiz, x}$	49.60	46.84	kN(/m)
$V_{H, vert, x}$	56.22	53.05	kN/m
$V_{H, horiz, y}$	28.90	26.12	kN/m
$V_{H, vert, y}$	32.82	29.64	kN/m
	SLS		
$V_{H, horiz, x}$	7.50	7.08	kN/m
$V_{H, vert, x}$	8.73	8.24	kN/m
$V_{H, horiz, y}$	4.38	3.95	kN/m
$V_{H, vert, y}$	5.11	4.61	kN/m

Overturning Moment above floor slab, M_w	=SQRT(((Cd_Ti__horiz*((Wlx*hlx)+(L47*M18)))^2)+((Cd_Tc__x*Wcx*hcx)^2))		
W_w	Walls 1, 2 & 3	Wall 4 & 5	
Tank wall weight (per m section)	54	42	kN
	ULS		
$M_{w, horiz, x}$	103.81	97.05	kNm/m
$M_{w, vert, x}$	117.24	109.45	kNm/m
$M_{w, horiz, y}$	62.60	55.74	kNm/m
$M_{w, vert, y}$	70.91	63.04	kNm/m
	SLS		
$M_{w, horiz, x}$	15.66	14.62	kNm/m
$M_{w, vert, x}$	18.16	16.94	kNm/m
$M_{w, horiz, y}$	9.46	8.42	kNm/m
$M_{w, vert, y}$	18.34	17.63	kNm/m

ULS

Sheet 13
Date 27/07/20

Load Case 10	**1.2G + 1.2 F_{lp}**
Note: no horizontal gravity force so no need to consider	
Max pressure at bottom	49.05 kPa
Shear	122.63 kN/m
Moment	204.38 kNm/m
With loading factor	
Shear	147.15 kN/m
Moment	245.25 kNm/m

SLS

sheet 15
Date 27/07/20

Load Case 6 - Full Tank			$G + F_{lp} + E_{s1}$	
Liquid Pressure				
Shear	122.63			kN/m
Moment	204.38			kNm/m
Earthquake				
Part 1 - Horizontal only				
X-direction				
	Walls 1, 2 & 3	Wall 4 & 5		
Shear	7.50	7.08		kN/m
Moment	15.66	14.62		kNm/m
y-direction				
Shear	4.38	3.95		kN/m
Moment	9.46	8.42		kNm/m
Part 2				
alpha	0.9	~~Cv(Tcx)~~	~~0.00~~	
Cv(Ti)	0.05	~~Cv(Tcy)~~	~~0.00~~	
Impulsive		~~Convective x direction~~		
Shear	6.51	~~Shear~~	~~0.05~~	kN/m
Moment	10.85	~~Moment~~	~~0.09~~	kNm/m
~~Convective y direction~~				
~~Shear~~	~~0.17~~			kN/m
~~Moment~~	~~0.29~~			kNm/m
~~Combo~~				
~~X-direction~~		~~y-direction~~		
~~Shear~~	~~6.51~~	~~Shear~~	~~6.51~~	kN/m
~~Moment~~	~~10.85~~	~~Moment~~	~~10.86~~	kNm/m
Eu				
x direction				
	Walls 1, 2 & 3	Wall 4 & 5		
shear	10	10		kN/m
moment	19	18		kNm/m
y direction				
	Walls 1, 2 & 3	Wall 4 & 5		
shear	8	8		kN/m
moment	14	14		kNm/m
Total				
x direction				
	Walls 1, 2 & 3	Wall 4 & 5		
shear	133	132		kN/m
moment	223	223		kNm/m
y direction				
	Walls 1, 2 & 3	Wall 4 & 5		
shear	130	130		kN/m
moment	219	218		kNm/m

SLS

Sheet 16

Date 27/07/20

Load Case 2	G + F_{lp}
Liquid Pressure	
Shear	122.63 kN/m
Moment	204.38 kNm/m

CALCULATION SHEET

Project/Task/File No: 1-13586.001
Project Description: Mangawhai Balance Tank - Concept Design - Final loading demands.
Sheet No 17 of
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Check: / /

Note: Assume wall 3 not tapered.

Final loading from s/s

ULS

Governing load case = 13 G + Eu + Fep

Walls 1, 2 & 3: x-direction Shear = $\boxed{191\ kN}$ Moment = $\boxed{334\ kNm}$

y - direction Shear = 178 kN Moment = 304 kNm

Walls 4 & 5: x - direction shear = $\boxed{189\ kN}$ Moment = $\boxed{329\ kNm}$

y - direction shear = 176 kN Moment = 300 kNm

SLS

Governing load case = 6 G + Fep + E_{s1}

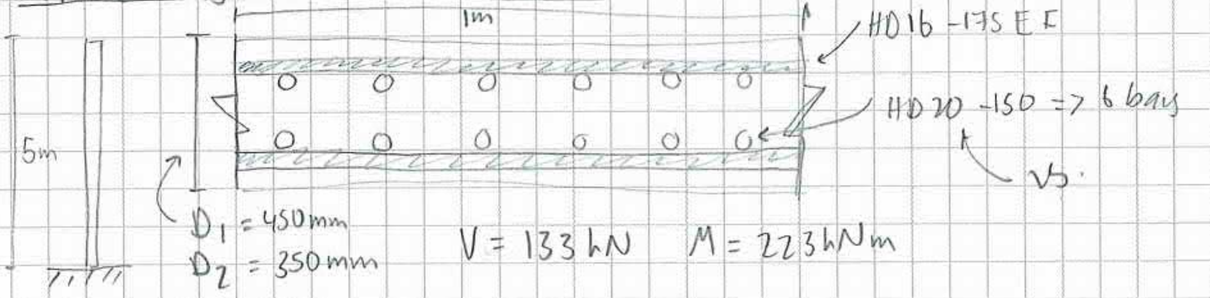
Walls 1, 2 & 3: x-direction $\boxed{\text{shear} = 133\ kN}$ $\boxed{M = 223\ kNm}$

y - direction V = 132 kN M = 223 kNm

Walls 4 & 5: x $\boxed{\text{shear} = 130\ kN}$ $\boxed{M = 219\ kNm}$

y V = 130 kN M = 218 kN

Serviceability check - crack widths



V = 133 kN M = 223 kNm

$$\rho_p = \frac{A_s}{A_{c,eff}} \qquad A_s = 6 \times \pi \frac{d^2}{4} = 6 \times \pi \times \frac{(20mm)^2}{4} = 1,885\ mm^2$$

$A_{c,eff} = \alpha_2 \times l$ when $\alpha_2 = 0.5D$ but not greater than 250 mm

$\Rightarrow \alpha_{2,w1} = 225\ mm \qquad \alpha_{2,w2} = 175\ mm$

$\Rightarrow A_{c,eff\,w_1} = 225\ mm \times 1000\ mm = 225,000\ mm^2 \qquad A_{ceff,w_2} = 175 \times 1000 = 175,000\ mm^2$

CALCULATION SHEET

Project/Task/File No: 1-13586.00/ Sheet No 18 of
Project Description: Manganwhai Balance Tank - concept design - Serviceability
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$$\rho_{pw_1} = \frac{1885}{225,000} = 0.0084 \qquad \rho_{pmin} = \frac{f_{ct.3}}{f_y}$$

$\rightarrow f'_c = 50\ MPa$

$$\rho_{pw_2} = \frac{1885}{175,000} = 0.011$$

$\Rightarrow$ Table C5.2.3 $f_{ct.3} = 2.44MPa$

$f_y = 500\ MPa$

$$\Rightarrow \rho_{pmin} = \frac{2.44}{500} = 0.0049 \quad ✓✓$$

$b = 1000mm$

depth of steel =

① $450 - 50 - 16 - 10 = 374mm$

② $350 -$ " " $= 274mm$

$$E_c = 3320\sqrt{f'_c} + 6900$$

cl 5.2.3 NZS 3101

$$= 3320\sqrt{50} + 6900$$

$$= 30,376\ MPa$$

$E_s = 200,000\ MPa$

$$n = \frac{200,000}{30,376} = 6.58$$

$\rho_1 = 0.0084 \quad \rho_2 = 0.011$

$$\rho_1 n = 0.0084 \times 6.58 = 0.055$$

$$\rho_2 n = 0.011 \times 6.58 = 0.072$$

$$k_1 = \sqrt{\rho_1 n^2 + 2\rho_1 n} - \rho_1 n$$

$$= \sqrt{(0.055)^2 + 2(0.055)} - 0.055 = 0.058$$

$$k_2 = \sqrt{(0.072)^2 + 2(0.072)} - 0.072 = 0.314$$

$$k_1 d_1 = 374mm \times 0.058 = 21.7mm$$

$$k_2 d_2 = 274 \times 0.314 = 86.0mm$$

CALCULATION SHEET

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$$j_1 = 1 - \frac{k}{3} = 1 - \frac{0.058}{3} = 0.981$$

$$j_2 = 1 - \frac{0.314}{3} = 0.895$$

$$f_s 1 = \frac{M}{A_s j d} = \frac{223\,kNm}{1885\,mm^2 \times 0.981 \times 374} \times 1 \times 10^6$$

$$= \underline{322\ MPa}$$

$$f_{s_2} = \frac{223\,kNm}{1885 \times 0.895 \times 274} = \underline{482.41\ MPa}$$

Try with 25mm bars, using s/s, for f_{s1}

f_{s1} = $\underline{205\ MPa}$ ✓✓

<u>Note</u> E_c is calculated using an updated equation $E_c = 4700 \times \sqrt{f'_c} \times \left(\frac{\rho}{2300}\right)^{1.5}$

⇒ E_c slightly different to using other eq.

⇒ need to model walls 4 & 5 ~~as~~ two way spanning.

⇒ Need to work out graph for model / reading off tables.

Check crack widths using 3101 method

<u>Walls 1-3</u> 25mm bars, 450 thick, cover = 50 + 16mm = 66 mm
spacing = 150 mm 50MPa concrete, b = 1000mm, $M^* SLS$ = 223kNm

Limit: using 3106

h_D / t = 5m / 0.45m = 11.11 ⇒ $w_k \leq 0.2$ mm

Limit: Using 3101, Load category: III

⇒ 0.3 mm limit ?

Exposure classification = B1 or B2
~~A1~~, (A2 B1 B2), C U

Working with 0.2 mm limit.

Using 3101 s/s W = 0.284 mm > 0.2 ⇒ Not OK

Try @ 100 spacing W = 0.168mm < 0.2 ⇒ OK

⇒ Starters at the bottom = HD25 @ 100 c/c spacing

Sheet 20
Date 27/07/20

wsp **CALCULATIONS**		PROJECT No / Ref **1-14129.07 / 00001**
OFFICE **Christchurch**	PROJECT TITLE **Mangawhai CWWTP Balance Tank** **Concept Design** **Walls 1-3**	
SUBJECT **SLS Crack Control - Walls 1-3**		SHEET No **1 OF 1**

Calculations to NZS3101 Cl. 2.4.4.6 Assessment of surface crack widths

Limit	=	0.2	mm	*Specified crack width limit*	*AS/NZS 3101*	*Table C2.1*
Thickness	=	450	mm	*Overall thickness of concrete*		
Cover	=	66	mm	*Cover to main steel*		
Bar	=	25	mm diam	*Main steel diameter*		
Spacing	=	100	mm	*Main steel spacing*		
F'c	=	50	Mpa	*Concrete strength*		
ρ	=	2450	kg/m3	*Concrete density*	*AS/NZS 3101*	*Cl. 5.2.2*
Ec	=	**37**	Gpa	*Concrete Modulus of Elasticity*	*AS/NZS 3101*	*Eq. 5-1*
Es	=	200	Gpa	*Steel Modulus of Elasticity*	*AS/NZS 3101*	*Cl. 5.3.4*
b	=	1000	mm	*Width of section*		
M^*_{SLS}	=	225	kNm	*SLS moment demand*		

Follows the example provided by SCNZ for "Durability of Composite Decks Exposed to Surface Water" dated 7 Nov. 2008
Available Here: https://www.scnz.org/site/scnz/images/advisor_doc/CMP1003.pdf

d	=		**371.5**	mm	*Distance to centroid main steel*		
n	=	$\frac{E_S}{E_C}$	**5.47**		*Standard flexural theory*		
A_s	=		**4909**		*Area of steel*		
ρ	=	$\frac{A_s}{bd}$	**0.0132**		*Reinforcement ratio*		
ρn	=	$\rho \times n$	**0.0723**				
k	=	$\sqrt{\rho n^2 + 2\rho n} - \rho n$	**0.315**				
kd	=	$k \times d$	**117.0**	mm	*Depth of Neutral Axis*		
j	=	$1 - \frac{k}{3}$	**0.895**				
f_s	=	$\frac{M^*}{A_s jd}$	**138**	Mpa			
β'	=	$\frac{y - kd}{d - kd}$	**1.31**			*AS/NZS 3101*	*Eq. 2-8*
g_s	=	$\sqrt{\left(\frac{S}{2}\right)^2 + {C_m}^2}$	**93**	mm		*AS/NZS 3101*	*Eq. 2-9*
w	=	$2\beta' \frac{f_s}{g_s} E_S$	**0.168**	mm		*AS/NZS 3101*	*Eq. 2-7*

Overall OK

CALCULATION SHEET

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Project Description: Mangawhai Balance Tank
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– Concept Design – Serviceability
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Walls 4&5 – Two-way spanning

Using data from 'Moment & Reactions for Rectangular Plates' – sheets used attached.

→ Estimate pressures of Load case 6 $= G + F_{ep} + E_{s,}$ $G = 0$

① F_{ep}, ② $E_{S1} = [\text{Imp} + \text{conv} + \text{wall}] + \text{Vert}$

F_{ep}

$\text{Max } P = 9.81\ \text{kN/m}^3 \times 5\text{m}$
$= 49.05\ \text{kPa}$

(reduction)

✓ Imp =

Top max = 4.21 kPa
Bottom = 25.88 kPa

Conv ✓

Top = 49.86 kPa
Bottom = 34.65 kPa

Wall ✓

$= 0.059 \times 24\ \text{kN/m}^3 \times 5\text{m}$
$= 7.08\ \text{kPa}$

Vert

$\text{Max} = 49.05 \times 0.05$
$= 2.45\ \text{kPa}.$

⇒ Part 1

$$\text{TOP} = \sqrt{\left[0.24 \times (4.21\ \text{kPa} + 7.08\ \text{kPa})\right]^2 + \left[0.03 \times 49.86\ \text{kPa}\right]^2}$$
$$= 3.095\ \text{kPa}$$

Bottom = 7.978 kPa

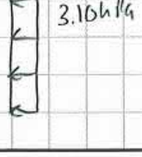
⇒ Part 1 & 2

Top = 3.095 kPa

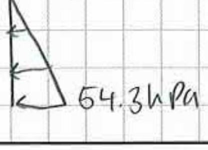
$$\text{Bottom} = \sqrt{7.978\ \text{kPa}^2 + 2.45\ \text{kPa}^2} = 8.346\ \text{kPa}$$

Total Top = 3.095 kPa
= 3.10 kPa
Bottom = 8.346 kPa + 49.05 kPa = 57.40 kPa

section ① ⇒



section ②



CSF 400 (7/2000)

CALCULATION SHEET

Project/Task/File No: 1-13586.00/

Project Description: Mangawhai Balance Tank - concept design - two way spanning walls

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<u>Section 1</u>

$a/b = \frac{7.5/2}{5} = 0.75 \qquad y/b = 0 \qquad x/a = 1$

$M_{①x} = 3.10\text{ kPa} \times 0.0242 \times 5\text{m}^2 = 1.88\text{ kNm}$

$M_{①y} =$ ~~8~~ $3.10 \times 0.1212 \times 5\text{m}^2 = 9.39\text{ kNm}$

<u>Section 2</u>

$M_{②x} = 54.3 \times 0.0117 \times 5^2 = 15.88\text{ kNm}$

$M_{②y} = 54.3 \times 0.0584 \times 5^2 = 79.28\text{ kNm}$

=> <u>Total</u> $M_x = 17.76\text{ kNm}$

$M_y = 88.67\text{ kNm}$

=> Now try in 3101 crack width s/s to check steel stress (vertical steel)

<u>$f_s = 169\text{ MPa} < 240\text{ MPa}$ ✓✓</u>

=> try HD20 @ 150 spacing for crack widths w/ 0.2mm limit

$W = 0.247\text{ mm} > 0.2$ ×× <u>Not OK</u>

try HD 20 @ 100 spacing

$W = 0.145\text{ mm}$ ✓✓ OK

=> <u>HD20 @ 100 spacing</u>

→ Now as two way spanning - check horizontal steel - <u>HD 16 @ 175 c/c</u>

Cover = 50mm, $M = 17.76\text{ kNm}$ $W = 0.074\text{ mm}$ ✓✓ OK

$$\frac{w l^2}{8}$$

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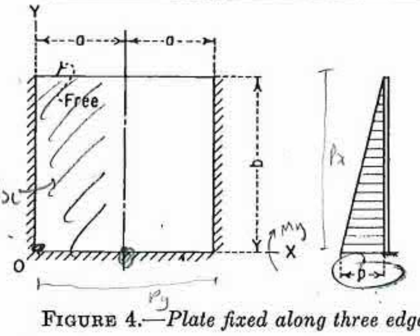
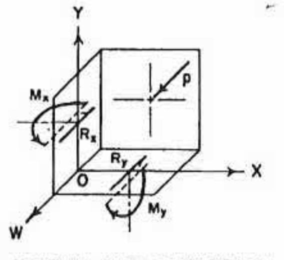
			Mx horiz steel						My vert steel					
	y/b	Rx ╲ x/a	0	0.2	0.4	0.6	0.8	1.0	0	0.2	0.4	0.6	0.8	1.0
a/b = 1/8	1.0	+.0082	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002	0	0	0	0	0	0
	0.8	+.0251	+.0011	+.0005	+.0000	-.0003	-.0005	-.0005	+.0002	+.0001	+.0000	-.0000	-.0001	-.0001
	0.6	+.0496	+.0021	+.0009	+.0001	-.0006	-.0009	-.0011	+.0004	+.0002	+.0000	-.0001	-.0002	-.0002
	0.4	+.0751	+.0031	+.0014	+.0001	-.0008	-.0014	-.0016	+.0006	+.0003	+.0000	-.0002	-.0003	-.0003
	0.2	+.0942	+.0038	+.0016	+.0000	-.0010	-.0017	-.0019	+.0008	+.0003	-.0000	-.0003	-.0005	-.0005
	0	+.0460	0	+.0001	+.0003	+.0005	+.0006	+.0006	0	+.0005	+.0014	+.0023	+.0028	+.0030
		Rx ╲ Ry	+.0460	+.0136	+.0543	+.0839	+.1004	+.1056						
a/b = 1/4	1.0	+.0147	+.0022	+.0012	+.0002	-.0006	-.0012	-.0014	0	0	0	0	0	0
	0.8	+.0523	+.0046	+.0022	+.0002	-.0012	-.0021	-.0024	+.0009	+.0005	+.0002	-.0000	-.0002	-.0002
	0.6	+.1015	+.0083	+.0037	+.0002	-.0023	-.0038	-.0042	+.0017	+.0007	-.0000	-.0005	-.0009	-.0010
	0.4	+.1514	+.0114	+.0049	+.0001	-.0032	-.0051	-.0057	+.0023	+.0008	-.0004	-.0013	-.0019	-.0021
	0.2	+.1494	+.0102	+.0037	-.0004	-.0030	-.0043	-.0047	+.0020	+.0004	-.0011	-.0022	-.0029	-.0031
	0	+.0304	0	+.0004	+.0010	+.0016	+.0020	+.0021	0	+.0020	+.0052	+.0081	+.0100	+.0107
		Rx ╲ Ry	+.0304	+.0309	+.1052	+.1563	+.1856	+.1950						
a/b = 3/8	1.0	+.0189	+.0066	+.0040	+.0008	-.0020	-.0039	-.0045	0	0	0	0	0	0
	0.8	+.0885	+.0117	+.0056	+.0006	-.0031	-.0054	-.0062	+.0023	+.0012	+.0004	-.0002	-.0005	-.0007
	0.6	+.1541	+.0176	+.0075	+.0001	-.0049	-.0079	-.0088	+.0035	+.0013	-.0006	-.0020	-.0029	-.0032
	0.4	+.2107	+.0208	+.0079	-.0007	-.0061	-.0090	-.0099	+.0042	+.0009	-.0019	-.0042	-.0056	-.0061
	0.2	+.1691	+.0145	+.0045	-.0012	-.0042	-.0057	-.0061	+.0029	+.0001	-.0022	-.0039	-.0048	-.0051
	0	+.0102	0	+.0008	+.0020	+.0030	+.0038	+.0040	0	+.0039	+.0099	+.0152	+.0188	+.0200
		Rx ╲ Ry	+.0102	+.0474	+.1488	+.2154	+.2526	+.2645						
a/b = 1/2	1.0	+.0326	+.0151	+.0088	+.0015	-.0046	-.0084	-.0097	0	0	0	0	0	0
	0.8	+.1315	+.0216	+.0099	+.0007	-.0059	-.0099	-.0112	+.0043	+.0020	+.0002	-.0011	-.0019	-.0022
	0.6	+.1972	+.0273	+.0108	-.0005	-.0079	-.0119	-.0132	+.0055	+.0015	-.0020	-.0047	-.0064	-.0070
	0.4	+.2421	+.0277	+.0092	-.0019	-.0082	-.0115	-.0125	+.0055	+.0004	-.0042	-.0076	-.0097	-.0104
	0.2	+.1607	+.0160	+.0041	-.0017	-.0044	-.0055	-.0058	+.0032	-.0002	-.0026	-.0039	-.0044	-.0046
	0	-.0045	0	+.0014	+.0033	+.0050	+.0061	+.0065	0	+.0068	+.0167	+.0252	+.0307	+.0325
		Rx ╲ Ry	-.0045	+.0744	+.1942	+.2699	+.3108	+.3236						
a/b = 3/4	1.0	+.1061	+.0406	+.0196	+.0013	-.0115	-.0190	-.0214	0	0	0	0	0	0
	0.8	+.2077	+.0433	+.0177	-.0003	-.0119	-.0184	-.0205	+.0087	+.0031	-.0012	-.0042	-.0061	-.0067
	0.6	+.2408	+.0426	+.0145	-.0026	-.0124	-.0174	-.0189	+.0085	+.0010	-.0055	-.0102	-.0130	-.0139
	0.4	+.2542	+.0349	+.0091	-.0039	-.0102	-.0130	-.0138	+.0070	-.0011	-.0075	-.0115	-.0137	-.0143
	0.2	+.1337	+.0163	+.0031	-.0017	-.0031	-.0033	-.0033	+.0033	+.0001	-.0000	+.0014	+.0029	+.0035
	0	-.0196	0	+.0028	+.0064	+.0093	+.0111	+.0117	0	+.0139	+.0320	+.0465	+.0554	+.0584
		Rx ╲ Ry	-.0196	+.1256	+.2666	+.3496	+.3923	+.4055						
a/b = 1	1.0	+.1985	+.0644	+.0253	-.0013	-.0172	-.0252	-.0276	0	0	0	0	0	0
	0.8	+.2564	+.0601	+.0210	-.0028	-.0161	-.0226	-.0245	+.0120	+.0034	-.0026	-.0065	-.0088	-.0095
	0.6	+.2485	+.0515	+.0149	-.0047	-.0145	-.0189	-.0201	+.0103	+.0003	-.0075	-.0125	-.0151	-.0159
	0.4	+.2411	+.0372	+.0078	-.0049	-.0100	-.0118	-.0122	+.0074	-.0021	-.0076	-.0099	-.0106	-.0107
	0.2	+.1108	+.0154	+.0025	-.0006	-.0006	-.0000	+.0003	+.0031	+.0018	+.0060	+.0116	+.0160	+.0175
	0	-.0241	0	+.0044	+.0096	+.0137	+.0161	+.0169	0	+.0220	+.0482	+.0683	+.0804	+.0845
		Rx ╲ Ry	-.0241	+.1691	+.3199	+.4038	+.4457	+.4584						
a/b = 3/2	1.0	+.3127	+.0857	+.0207	-.0087	-.0199	-.0232	-.0238	0	0	0	0	0	0
	0.8	+.2929	+.0730	+.0158	-.0086	-.0172	-.0194	-.0198	+.0146	+.0023	-.0042	-.0072	-.0082	-.0085
	0.6	+.2352	+.0560	+.0094	-.0083	-.0134	-.0142	-.0141	+.0112	-.0013	-.0077	-.0096	-.0096	-.0094
	0.4	+.2148	+.0359	+.0038	-.0053	-.0065	-.0057	-.0053	+.0072	-.0021	-.0023	+.0012	+.0046	+.0059
	0.2	+.0897	+.0132	+.0021	+.0025	+.0050	+.0069	+.0076	+.0026	+.0077	+.0220	+.0356	+.0444	+.0474
	0	-.0204	0	+.0079	+.0158	+.0212	+.0243	+.0252	0	+.0396	+.0791	+.1062	+.1214	+.1262
		╲ Ry	-.0204	+.2452	+.3964	+.4668	+.4966	+.5047						



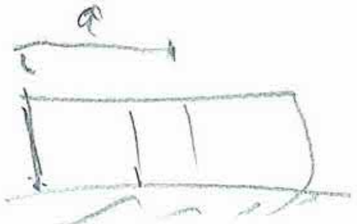
Moment = (Coefficient)(pb^2)
Reaction = (Coefficient)(pb)

p kN/m



POSITIVE SIGN CONVENTION

FIGURE 4.—*Plate fixed along three edges, moment and reaction coefficients, Load IV, uniformly varying load.*



Ph
½ h

(V)

X = a $\frac{X}{a}$ = 1.0

Sheet: 24
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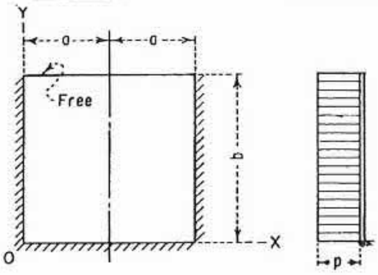
RESULTS

Horizontal steel   vertical steel

			M_x						M_y					
	y/b	R_x \ x/a	0	0.2	0.4	0.6	0.8	1.0	0	0.2	0.4	0.6	0.8	1.0
a/b = 1/8	1.0	+.1249	+.0052	+.0024	+.0002	-.0014	-.0024	-.0027	0	0	0	0	0	0
	0.8	+.1248	+.0051	+.0023	+.0002	-.0014	-.0023	-.0026	+.0010	+.0005	+.0000	-.0003	-.0005	-.0005
	0.6	+.1247	+.0052	+.0023	+.0002	-.0014	-.0023	-.0027	+.0010	+.0005	+.0000	-.0003	-.0005	-.0005
	0.4	+.1250	+.0051	+.0023	+.0001	-.0014	-.0023	-.0027	+.0010	+.0005	+.0000	-.0003	-.0005	-.0006
	0.2	+.1185	+.0048	+.0021	+.0001	-.0013	-.0021	-.0024	+.0010	+.0004	-.0001	-.0004	-.0006	-.0007
	0	+.0504	0	+.0001	+.0003	+.0005	+.0006	+.0007	0	+.0006	+.0016	+.0025	+.0031	+.0033
		R_x \ R_y	+.0504	+.0116	+.0568	+.0893	+.1084	+.1141						
a/b = 1/4	1.0	+.2483	+.0209	+.0096	+.0007	-.0057	-.0096	-.0109	0	0	0	0	0	0
	0.8	+.2523	+.0206	+.0093	+.0006	-.0056	-.0093	-.0105	+.0041	+.0019	+.0002	-.0009	-.0016	-.0019
	0.6	+.2513	+.0205	+.0093	+.0006	-.0056	-.0093	-.0105	+.0041	+.0018	+.0000	-.0013	-.0021	-.0023
	0.4	+.2512	+.0196	+.0085	+.0003	-.0054	-.0088	-.0099	+.0039	+.0016	-.0004	-.0018	-.0027	-.0030
	0.2	+.1905	+.0137	+.0053	-.0003	-.0039	-.0059	-.0065	+.0027	+.0007	-.0011	-.0024	-.0032	-.0034
	0	+.0295	0	+.0005	+.0013	+.0020	+.0025	+.0027	0	+.0023	+.0063	+.0101	+.0126	+.0135
		R_x \ R_y	+.0295	+.0236	+.1131	+.1786	+.2174	+.2301						
a/b = 3/8	1.0	+.3711	+.0476	+.0219	+.0016	-.0130	-.0218	-.0247	0	0	0	0	0	0
	0.8	+.3896	+.0466	+.0208	+.0012	-.0126	-.0208	-.0235	+.0093	+.0042	+.0004	-.0022	-.0038	-.0043
	0.6	+.3757	+.0442	+.0193	+.0007	-.0122	-.0198	-.0223	+.0088	+.0036	-.0007	-.0039	-.0059	-.0065
	0.4	+.3541	+.0379	+.0155	-.0003	-.0107	-.0167	-.0186	+.0076	+.0024	-.0021	-.0054	-.0075	-.0082
	0.2	+.2133	+.0210	+.0075	-.0009	-.0059	-.0085	-.0093	+.0042	+.0009	-.0017	-.0034	-.0044	-.0047
	0	-.0015	0	+.0010	+.0027	+.0043	+.0054	+.0058	0	+.0050	+.0135	+.0215	+.0269	+.0288
		R_x \ R_y	-.0015	+.0303	+.1666	+.2644	+.3220	+.3410						
a/b = 1/2	1.0	+.5101	+.0852	+.0384	+.0022	-.0233	-.0383	-.0432	0	0	0	0	0	0
	0.8	+.5331	+.0807	+.0349	+.0013	-.0218	-.0353	-.0397	+.0161	+.0068	-.0001	-.0049	-.0077	-.0086
	0.6	+.4805	+.0712	+.0298	-.0000	-.0199	-.0313	-.0350	+.0142	+.0051	-.0026	-.0084	-.0120	-.0132
	0.4	+.4148	+.0545	+.0209	-.0014	-.0156	-.0233	-.0258	+.0109	+.0026	-.0043	-.0094	-.0125	-.0135
	0.2	+.1928	+.0250	+.0087	-.0009	-.0063	-.0089	-.0096	+.0050	+.0015	-.0003	-.0008	-.0008	-.0007
	0	-.0294	0	+.0019	+.0050	+.0080	+.0100	+.0107	0	+.0094	+.0252	+.0399	+.0499	+.0534
		R_x \ R_y	-.0294	+.0482	+.2263	+.3559	+.4322	+.4572						
a/b = 3/4	1.0	+.8592	+.1788	+.0716	-.0010	-.0471	-.0726	-.0807	0	0	0	0	0	0
	0.8	+.7864	+.1552	+.0607	-.0020	-.0414	-.0630	-.0698	+.0310	+.0112	-.0027	-.0119	-.0172	-.0190
	0.6	+.5989	+.1207	+.0460	-.0033	-.0336	-.0498	-.0549	+.0241	+.0071	-.0067	-.0166	-.0225	-.0245
	0.4	+.4378	+.0786	+.0280	-.0033	-.0214	-.0306	-.0333	+.0157	+.0036	-.0049	-.0100	-.0127	-.0135
	0.2	+.1185	+.0289	+.0109	+.0009	-.0034	-.0049	-.0053	+.0058	+.0060	+.0115	+.0186	+.0241	+.0262
	0	-.0694	0	+.0042	+.0115	+.0182	+.0227	+.0242	0	+.0212	+.0576	+.0911	+.1135	+.1212
		R_x \ R_y	-.0694	+.0806	+.3383	+.5271	+.6368	+.6725						
a/b = 1	1.0	+1.2115	+.2613	+.0883	-.0105	-.0654	-.0927	-.1008	0	0	0	0	0	0
	0.8	+.9558	+.2146	+.0727	-.0097	-.0551	-.0774	-.0840	+.0429	+.0134	-.0051	-.0464	-.0224	-.0243
	0.6	+.6250	+.1547	+.0525	-.0083	-.0411	-.0566	-.0611	+.0309	+.0090	-.0069	-.0169	-.0222	-.0238
	0.4	+.3984	+.0916	+.0305	-.0043	-.0216	-.0290	-.0310	+.0183	+.0069	+.0029	+.0030	+.0045	+.0053
	0.2	+.0434	+.0303	+.0127	+.0047	+.0033	+.0042	+.0048	+.0061	+.0149	+.0339	+.0542	+.0689	+.0742
	0	-.0939	0	+.0074	+.0199	+.0311	+.0384	+.0409	0	+.0369	+.0996	+.1556	+.1919	+.2043
		R_x \ R_y	-.0939	+.1167	+.4453	+.6760	+.8043	+.8450						
a/b = 3/2	1.0	+1.6267	+.3304	+.0700	-.0345	-.0730	-.0844	-.0865	0	0	0	0	0	0
	0.8	+1.0875	+.2609	+.0565	-.0286	-.0589	-.0670	-.0683	+.0522	+.0116	-.0069	-.0143	-.0165	-.0169
	0.6	+.5876	+.1778	+.0399	-.0195	-.0385	-.0422	-.0422	+.0356	+.0115	+.0017	+.0011	+.0035	+.0049
	0.4	+.3166	+.0981	+.0239	-.0056	-.0116	-.0101	-.0090	+.0196	+.0177	+.0315	+.0495	+.0634	+.0685
	0.2	-.0540	+.0302	+.0140	+.0140	+.0211	+.0273	+.0296	+.0060	+.0389	+.0912	+.1388	+.1699	+.1805
	0	-.1168	0	+.0159	+.0388	+.0565	+.0668	+.0702	0	+.0796	+.1939	+.2823	+.3340	+.3508
		R_y	-.1168	+.2429	+.6510	+.8793	+.9832	+1.0123						



Moment = (Coefficient) (pb^2)
Reaction = (Coefficient) (pb)

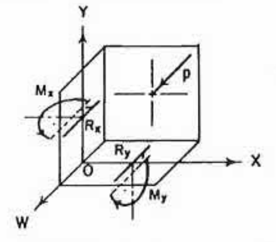


FIGURE 1.—*Plate fixed along three edges, moment and reaction coefficients, Load I, uniform load.*

Sheet 25
Date: 17/07/20

wsp	**CALCULATIONS**	PROJECT No / Ref **1-14129.07 / 00001**
OFFICE **Christchurch**	PROJECT TITLE **Mangawhai CWWTP Balance Tank** **Concept Design** **Walls ~~1&2~~ 4-5**	
SUBJECT **SLS Crack Control - Walls 4-5**	SHEET No 1 OF 1	

Calculations to NZS3101 Cl. 2.4.4.6 Assessment of surface crack widths

Limit	=	0.2	mm	*Specified crack width limit*	*AS/NZS 3101*	*Table C2.1*
Thickness	=	350	mm	*Overall thickness of concrete*		
Cover	=	66	mm	*Cover to main steel*		
Bar	=	20	mm diam	*Main steel diameter*		
Spacing	=	100	mm	*Main steel spacing*		
F'c	=	50	Mpa	*Concrete strength*		
ρ	=	2450	kg/m3	*Concrete density*	*AS/NZS 3101*	*Cl. 5.2.2*
Ec	=	37	Gpa	*Concrete Modulus of Elasticity*	*AS/NZS 3101*	*Eq. 5-1*
Es	=	200	Gpa	*Steel Modulus of Elasticity*	*AS/NZS 3101*	*Cl. 5.3.4*
b	=	1000	mm	*Width of section*		
M^*_{SLS}	=	88.67	kNm	*SLS moment demand*		

Follows the example provided by SCNZ for "Durability of Composite Decks Exposed to Surface Water" dated 7 Nov. 2008
Available Here: https://www.scnz.org/site/scnz/images/advisor_doc/CMP1003.pdf

d	=		274	mm	*Distance to centroid main steel*		
n	=	$\frac{E_s}{E_C}$	5.47		*Standard flexural theory*		
A_s	=		3142		*Area of steel*		
ρ	=	$\frac{A_s}{bd}$	0.0115		*Reinforcement ratio*		
ρn	=	$\rho \times n$	0.0628				
k	=	$\sqrt{\rho n^2 + 2\rho n} - \rho n$	0.297				
kd	=	$k \times d$	81.4	mm	*Depth of Neutral Axis*		
j	=	$1 - \frac{k}{3}$	0.901				
f_s	=	$\frac{M^*}{A_s jd}$	114	Mpa			
β'	=	$\frac{y - kd}{d - kd}$	1.39			*AS/NZS 3101*	*Eq. 2-8*
g_s	=	$\sqrt{\left(\frac{S}{2}\right)^2 + {C_m}^2}$	91	mm		*AS/NZS 3101*	*Eq. 2-9*
w	=	$2\beta' \frac{f_s}{g_s} E_s$	0.145	mm		*AS/NZS 3101*	*Eq. 2-7*

Overall OK

Sheet: 26
Date: 24/07/20

wsp

CALCULATIONS

PROJECT No / Ref
1-14129.07 / 00001

OFFICE
Christchurch

PROJECT TITLE
Mangawhai CWWTP Balance Tank
Concept Design
Walls 4-5

SUBJECT
SLS Crack Control - Walls 4-5 - Horizontal Steel

SHEET No
1 OF 1

Calculations to NZS3101 Cl. 2.4.4.6 Assessment of surface crack widths

Limit	=	0.2	mm	*Specified crack width limit*	*AS/NZS 3101*	*Table C2.1*
Thickness	=	350	mm	*Overall thickness of concrete*		
Cover	=	50	mm	*Cover to main steel*		
Bar	=	16	mm diam	*Main steel diameter*		
Spacing	=	175	mm	*Main steel spacing*		
F'c	=	50	Mpa	*Concrete strength*		
ρ	=	2450	kg/m3	*Concrete density*	*AS/NZS 3101*	*Cl. 5.2.2*
Ec	=	37	Gpa	*Concrete Modulus of Elasticity*	*AS/NZS 3101*	*Eq. 5-1*
Es	=	200	Gpa	*Steel Modulus of Elasticity*	*AS/NZS 3101*	*Cl. 5.3.4*
b	=	1000	mm	*Width of section*		
M^*_{SLS}	=	17.76	kNm	*SLS moment demand*		

Follows the example provided by SCNZ for "Durability of Composite Decks Exposed to Surface Water" dated 7 Nov. 2008
Available Here: https://www.scnz.org/site/scnz/images/advisor_doc/CMP1003.pdf

d	=		292	mm	*Distance to centroid main steel*		
n	=	$\frac{E_S}{E_C}$	5.47		*Standard flexural theory*		
A_s	=		1149		*Area of steel*		
ρ	=	$\frac{A_s}{bd}$	0.0039		*Reinforcement ratio*		
ρn	=	$\rho \times n$	0.0215				
k	=	$\sqrt{\rho n^2 + 2\rho n} - \rho n$	0.187				
kd	=	$k \times d$	54.6	mm	*Depth of Neutral Axis*		
j	=	$1 - \frac{k}{3}$	0.938				
f_s	=	$\frac{M^*}{A_s jd}$	56	Mpa			
β'	=	$\frac{y - kd}{d - kd}$	1.24			*AS/NZS 3101*	*Eq. 2-8*
g_s	=	$\sqrt{\left(\frac{S}{2}\right)^2 + {C_m}^2}$	105	mm		*AS/NZS 3101*	*Eq. 2-9*
w	=	$2\beta' \frac{f_s}{g_s} E_S$	0.074	mm		*AS/NZS 3101*	*Eq. 2-7*

Overall OK

CALCULATION SHEET

Project/Task/File No: 1-13586.00/
Project Description: Mangawhai Balance Tank
- Concept Design - starter length check.
Sheet No 27 of
Office: CHCH
Computed: 27/07/20
Check: / /

→ Need to check how far up walls 1-3 the 25mm starter bars are needed to keep crack widths < 0.2mm

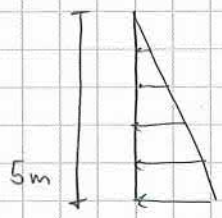
→ Using 3101 s/s and goal seek function, estimating the maximum M we can have for $w < 0.2$

When $w = 0.2$, $M^*_{SLS} = 185$ kNm

& $f_s = 172$ MPa

⇒ Need to work out at what height up the walls the demand = 185kNm

→ Conservatively assume the BMD is triangular rather than quadratic



$M_{max} = 223$kNm

$y = mx + c$ $\qquad m = {}^{223}/_{5} = 44.6$

$y = 44.6x$

$\Rightarrow 185 = 44.6\,x$

$\Rightarrow x = 4.15$ m

⇒ up the wall 0.85 m

⇒ length of starters = 0.85m + development length + thickness of wall

$$L_{db} = \frac{0.5\,\alpha_a f_y}{\sqrt{f'_c}}\, d_b \qquad \alpha_a = 1 \quad f_y = 500\text{ MPa} \quad f'_c = 50\text{MPa}$$

$$d_b = 25\text{mm}$$

$$= \frac{0.5 \times 1 \times 500\text{ MPa}}{\sqrt{50}} \times 25$$

$$= 883.88\text{ mm} \qquad = 885\text{ mm}$$

Base slab check HD16 EWEF
⇒ w/ 0.2mm crack width limit p_{pmin} % = 0.747

$p_{pmin} = 0.0049$
$= 0.49\%$ ✓✓

⇒ total length of starters = 0.85m + 0.885m + 0.45m
= 2.185
≈ 2.2m

L_{dc} for 20mm $= \frac{0.5 \times 1 \times 500}{\sqrt{50}} \times 20 = 707.1$ mm ⇒ 710 mm

Sheet 28
Date: 27/07/20

CALCULATIONS

PROJECT No / Ref
1-14129.07 / 00001

OFFICE
Christchurch

PROJECT TITLE
Mangawhai CWWTP Balance Tank
Concept Design
Walls 1-3

SUBJECT
SLS Crack Control - Walls 1-3

SHEET No
1 OF 1

Calculations to NZS3101 Cl. 2.4.4.6 Assessment of surface crack widths

Limit	=	0.2	mm	*Specified crack width limit*	*AS/NZS 3101*	*Table C2.1*
Thickness	=	450	mm	*Overall thickness of concrete*		
Cover	=	66	mm	*Cover to main steel*		
Bar	=	20	mm diam	*Main steel diameter*		
Spacing	=	100	mm	*Main steel spacing*		
F'c	=	50	Mpa	*Concrete strength*		
ρ	=	2450	kg/m3	*Concrete density*	*AS/NZS 3101*	*Cl. 5.2.2*
Ec	=	37	Gpa	*Concrete Modulus of Elasticity*	*AS/NZS 3101*	*Eq. 5-1*
Es	=	200	Gpa	*Steel Modulus of Elasticity*	*AS/NZS 3101*	*Cl. 5.3.4*
b	=	1000	mm	*Width of section*		
M^*_{SLS}	=	185.0056666	kNm	*SLS moment demand*		

Follows the example provided by SCNZ for "Durability of Composite Decks Exposed to Surface Water" dated 7 Nov. 2008
Available Here: https://www.scnz.org/site/scnz/images/advisor_doc/CMP1003.pdf

d	=		374	mm	*Distance to centroid main steel*		
n	=	$\frac{E_s}{E_C}$	5.47		*Standard flexural theory*		
A_s	=		3142		*Area of steel*		
ρ	=	$\frac{A_s}{bd}$	0.0084		*Reinforcement ratio*		
ρn	=	$\rho \times n$	0.0460				
k	=	$\sqrt{\rho n^2 + 2\rho n} - \rho n$	0.261				
kd	=	$k \times d$	97.5	mm	*Depth of Neutral Axis*		
j	=	$1 - \frac{k}{3}$	0.913				
f_s	=	$\frac{M^*}{A_s jd}$	172	Mpa			
β'	=	$\frac{y - kd}{d - kd}$	1.27			*AS/NZS 3101*	*Eq. 2-8*
g_s	=	$\sqrt{\left(\frac{S}{2}\right)^2 + {C_m}^2}$	91	mm		*AS/NZS 3101*	*Eq. 2-9*
w	=	$2\beta' \frac{f_s}{g_s} E_S$	0.200	mm		*AS/NZS 3101*	*Eq. 2-7*

Overall Not OK

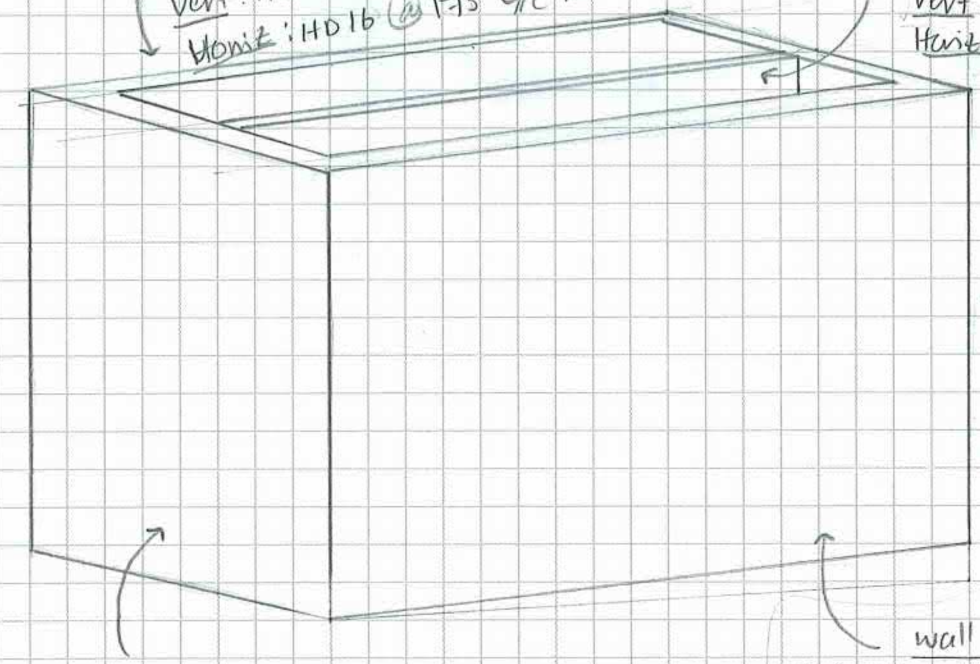
CALCULATION SHEET

Project/Task/File No: 1-13586.00 /
Project Description: Mangawhai Balance Tank - Concept Design - Sketch.

Sheet No 2 of
Office: CHCH
Computed: 27 / 07 / 20
Check: / /

Wall 1 450 thick
TOP: U bar HD20 @ 200
Bottom: starters HD25 @ 100 c/c EF
Vert: HD20 @ 100 c/c EF
Horiz: HD16 @ 175 C/C EF

Wall 2 450 thick
TOP: Ubar HD20 @ 200 c/c
Bottom: Starter HD25 @ 100 c/c EF
Vert: HD20 @ 100 c/c EF
Horiz: HD16 @ 175 c/c EF

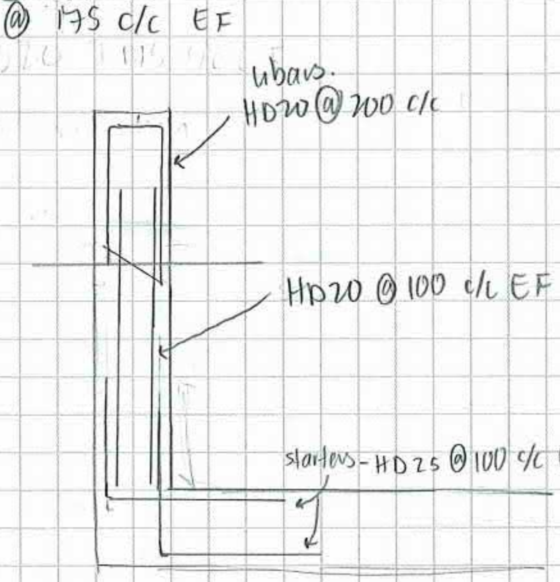


wall 5 350 thick
TOP: Ubar HD20 @ 200 c/c
bottom: Starters HD20 @ 100 c/c EF
Vert: HD20 @ 100 c/c EF
Horiz: HD16 @ 175 c/c EF

wall 4
350 thick.
TOP : Ubar HD20 @ 200 c/c
Bottom: starters HD20 @ 100 c/c EF
Vert: HD20 @ 100 c/c EF
Horiz: HD16 @ 175 c/c EF

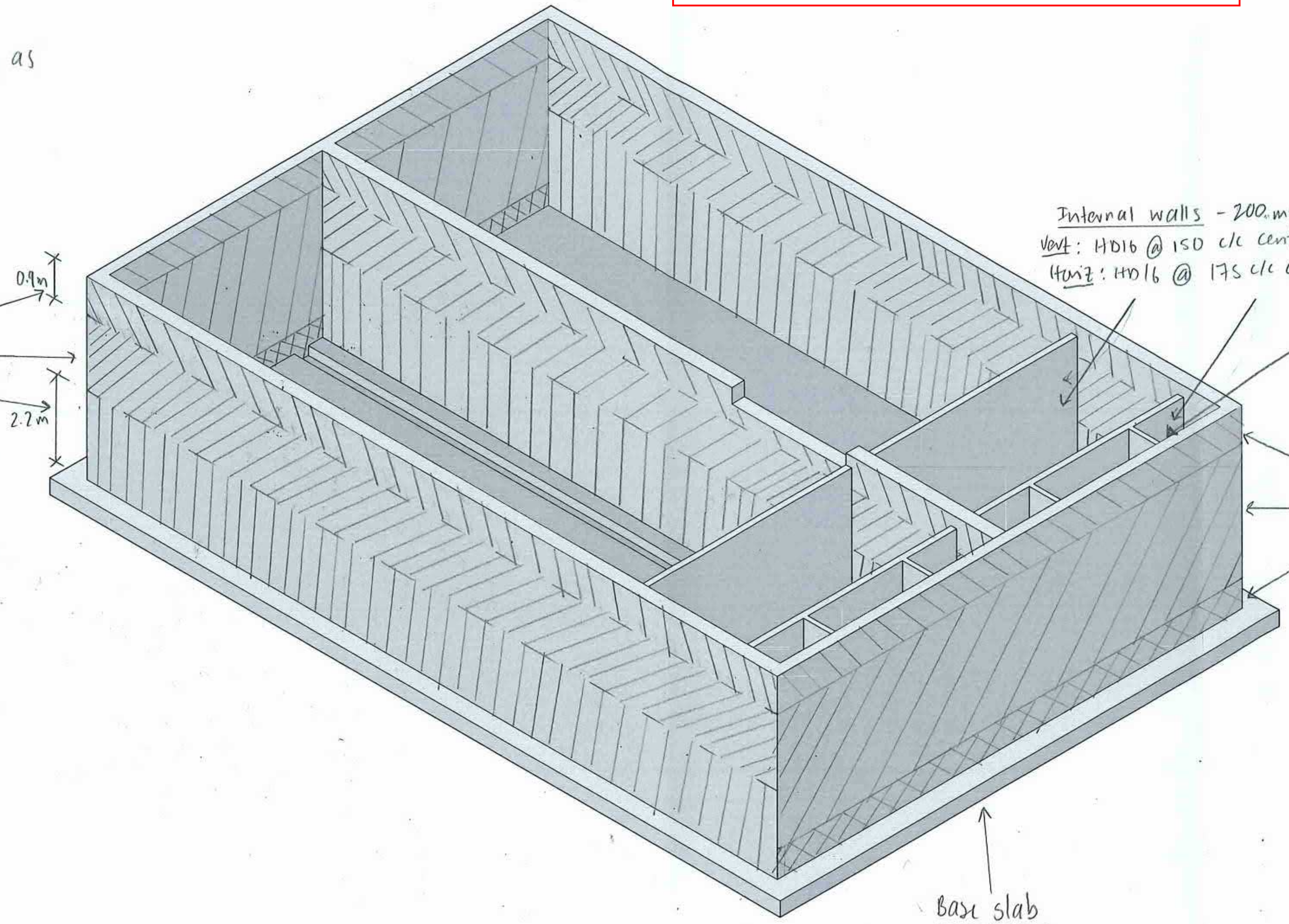
wall 3 450 thick
Top: Ubar HD20 @ 200 c/c
Bottom: starters HD25 @ 100 c/c EF
Vertical = HD 20 @ 100 c/c EF
Horiz = HD 16 @ 175 c/c EF

40 : 5000
17.6 : 2200
7.2 : 900
5.68 : 710



Sheet 30
Date: 27/07/2020

Note - 17/09/2020 -
Tank reduced to single tank post-calculation



Dividing wall
→ 450mm thick
Same reinforcing as
long outer walls

Long outer walls
→ 450mm thick
HD20 U bars @ 200 c/c
HD20 @ 100 c/c EF
HD25 starters @ 100 c/c FF
HD16 starters @ 100 c/c NF
Horizontals
HD16 @ 175 c/c EF

Internal walls - 200 mm thick
Vert: HD16 @ 150 c/c central
Horiz: HD16 @ 175 c/c central

Internal Walls - 150 mm thick
Vert: HD16 @ 150 c/c central
Horiz: HD16 @ 175 c/c central

Shorter Outer Walls
→ 350 mm thick
HD20 Ubars @ 200 c/c
HD20 @ 100 c/c EF
HD20 starters @ 100 c/c FF
HD16 starters @ 100 c/c NF
Horizontals
HD16 @ 175 c/c EF

Base slab
HD16 @ 250 c/c EW EF

BALANCE TANK - ISOMETRIC VIEW
SCALE: 1:75

1:75 @ A1
1:150 @ A3
0 1 2 3 4 5 6 7 m

REVISION	AMENDMENT	APPROVED	DATE
A	DRAFT FOR DISCUSSION	L.T.	2020-07-27

wsp
Christchurch Office
+64 3 363 5400
PO Box 1482
Christchurch 8140
New Zealand

STRUCTURAL

SCALES: 1:75
ORIGINAL SIZE: A1
DRAWN: K. HEWSON
DESIGNED: J. GALE
APPROVED: L. THOMAS
DRAWING VERIFIED: VERIFIER
DESIGN VERIFIED: S. ADAMS
APPROVED DATE: 2020-07-27

DRAFT FOR DISCUSSION

PROJECT
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT
TREATMENT PLANT
TITLE
BALANCE TANK
ISOMETRIC VIEW
WSP PROJECT NO. (SUB-PROJECT): 1-13586.00
SHEET NO.: SK001
REVISION: A

Original sheet size A1 (841x594) Plot Date 2020-07-27 at 12:18:56 PM C:\Users\chkjh0\Desktop\iso balance tank.dwg Layout1

sheet: 31
Date: 27/07/20

Dividing Wall 450 mm thick

Vertical

HD20 U-bars @ 200 c/c

HD20 straights @ 100 c/c EF

HD25 starters @ 100 c/c FF

HD16 starters @ 100 c/c NF

Horizontal

HD16 @ 175 c/c EF

Longer Perimeter Walls 450 mm thick

Vertical

HD20 U-bars @ 200 c/c

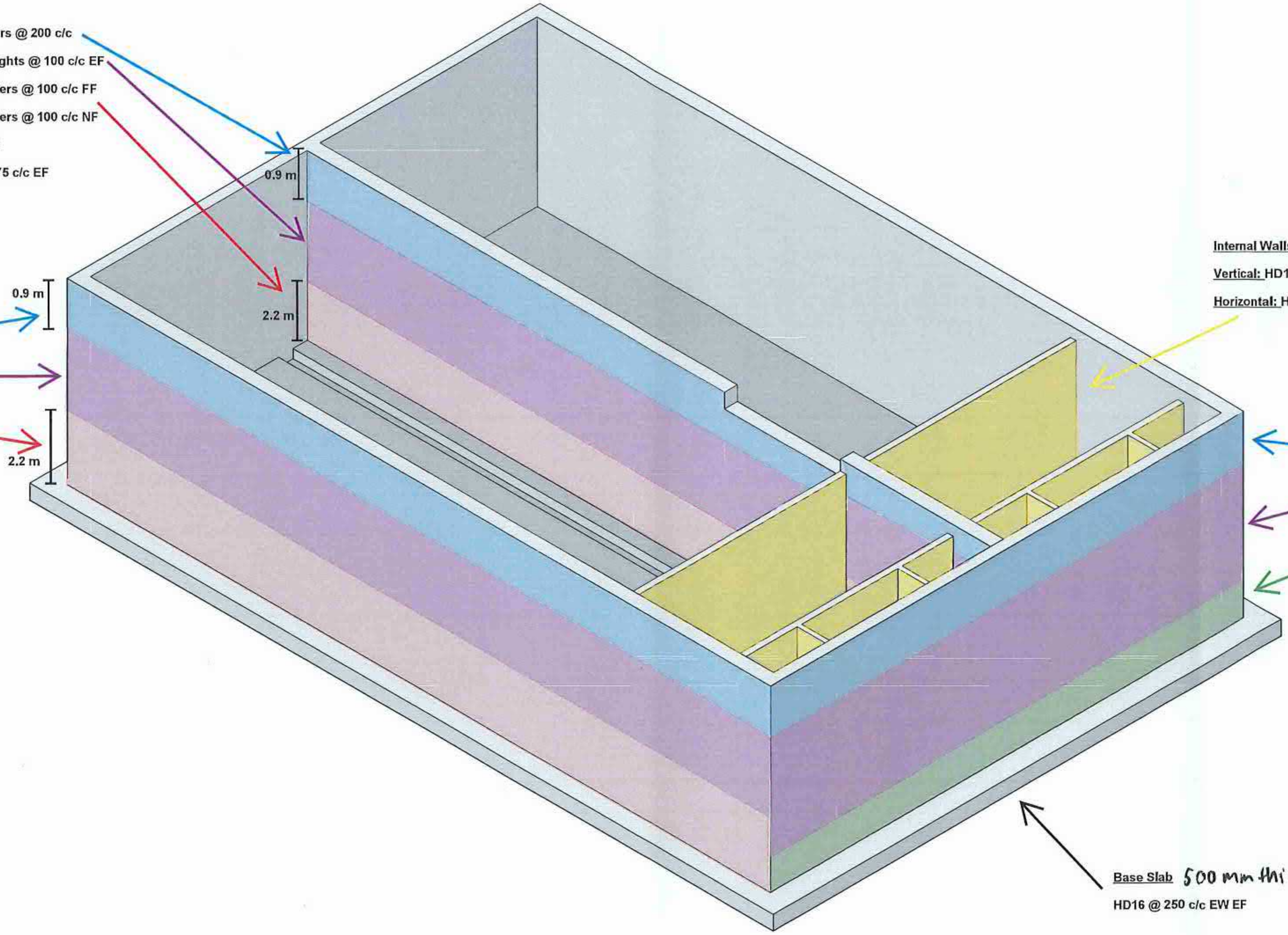
HD20 straights @ 100 c/c EF

HD25 starters @ 100 c/c FF

HD16 starters @ 100 c/c NF

Horizontal

HD16 @ 175 c/c EF



Internal Walls 200 mm thick

Vertical: HD16 @ 150 c/c central

Horizontal: HD16 @ 175 c/c central

Shorter Perimeter Walls 350 mm thick

Vertical

HD20 U-bars @ 200 c/c

HD20 straights @ 100 c/c EF

HD20 starters @ 100 c/c FF

HD16 starters @ 100 c/c NF

Horizontal

HD16 @ 175 c/c EF

Base Slab 500 mm thick

HD16 @ 250 c/c EW EF

BALANCE TANK - ISOMETRIC VIEW

SCALE: 1:75

ORIGINAL DRAWING IN COLOUR

1:75 @ A1
1:150 @ A3
0 1 2 3 4 5 6 7 m

REVISION	AMENDMENT	APPROVED	DATE
A	DRAFT FOR DISCUSSION	L.T.	2020-07-27

wsp
Christchurch Office
+64 3 363 5400
PO Box 1482
Christchurch 8140
New Zealand

STRUCTURAL

SCALES
1:75

ORIGINAL SIZE
A1

DRAWN	DESIGNED	APPROVED
K. HEWSON	J. GALE	L. THOMAS
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
VERIFIER	S. ADAMS	2020-07-27

DRAFT FOR DISCUSSION

PROJECT
MANGAWHAI ECOCARE
MANGAWHAI INFRASTRUCTURE PROJECT
TREATMENT PLANT

TITLE
BALANCE TANK
ISOMETRIC VIEW

WSP PROJECT NO. (SUB-PROJECT)
1-13586.00

SHEET NO.
SK001

REVISION
A

Original sheet size A1 (841x594) Plot Date 2020-07-27 at 12:18:56 PM C:\Users\chkjh0\Desktop\iso balance tank.dwg Layout1

Appendix F
Rough Order of Cost

2.5

Mangawhai Wastewater Plant

17/09/2020

Andrew Springer

Rev 1

Item	Description	Unit	Quantity	Rate	Total
1	Preliminary and General				$ 275,156.83
1.1	P&G	Ls	20%	$ 1,350,784.13	$ 270,156.83
1.2	Quality plan	Ls	1	$ 5,000.00	$ 5,000.00
2	Earthworks and Clearing				$ 82,470.00
2.1	Cut to waste for balance tank including both access platform and return pump	m3	260	$ 45.00	$ 11,700.00
2.2	Cut to waste for elevated screen and flow split base slab	m3	64	$ 45.00	$ 2,880.00
2.3	Cut to waste for odour control base slab	m3	10	$ 45.00	$ 450.00
2.4	Import and fill with river sand For all concrete slab bedding (0.5m)	m3	167	$ 250.00	$ 41,750.00
2.5	supply and lay 500mm thick crusher rock	m2	167	$ 70.00	$ 11,690.00
2.6	Cut to waste - slope cut back	m2	200	$ 70.00	$ 14,000.00
3	Drainage				$ 16,550.00
3.1	Supply and install clossed top concrete drain (400mm)	m	48	$ 20.00	$ 960.00
3.2	Cut to waste for concrete drain (0.5m deep)	m3	12	$ 45.00	$ 540.00
3.3	Supply and lay 50mm clear river sand for concrete pipe bedding	m3	2	$ 250.00	$ 500.00
3.4	Supply and install (675x 450) catchpit	No.	1	$ 3,300.00	$ 3,300.00
3.5	Supply and install 1050 MH	No.	1	$ 11,250.00	$ 11,250.00
4	Structures				$ 912,076.00
4.1	Concrete Slabs				$ 69,150.00
4.1.1	Concrete base slab for new balance tank (200mm thick) 25MPa	m3	51	$ 875.00	$ 44,625.00
4.1.2	Concrete base slab for ruturn pump (200mm thick) 20MPa	m3	2	$ 850.00	$ 1,700.00
4.1.3	Concrete base slab for access platform (200mm thick) 20MPa	m3	3	$ 850.00	$ 2,550.00
4.1.4	Concrete base slab for elevated screen and flow split (200mm thick) 25MPa	m3	3	$ 875.00	$ 2,625.00
4.1.5	Concrete base slab for odour control (200mm thick) 20MPa	m3	1	$ 850.00	$ 850.00
4.1.6	Total rebar in concrete slabs 10% of concrete	kg	6000	$ 2.80	$ 16,800.00
4.2	Balance Tank				$ 185,280.00
4.2.1	Supply and install cast insitu concrete walls 350mm thick at 5.65m high (25MPa)	m2	155	$ 900.00	$ 139,500.00
4.2.2	Supply and install cast insitu concrete walls 150mm thick at 5.65m high	m2	35	$ 900.00	$ 31,500.00
4.2.3	Total rebar in balance tank 10% of concrete - already in precast panesl	kg	5100	$ 2.80	$ 14,280.00
4.3	Access platform				$ 30,000.00
4.3.1	stair case with two (2 x 2m) platforms (total rise of 5.65m)	LS	1	$ 23,000.00	$ 23,000.00
4.3.2	Supply and install handrail on both sides running full length of stairs	m	14	$ 500.00	$ 7,000.00
4.4	Return pump				$ 1,020.00
4.4.1	supply and install concrete plinth for pumps with access hatch (2 x 3 x 1.5 @ 150mm thick) 20 Mpa inc rebar and formwork	m3	1	$ 1,020.00	$ 1,020.00
4.5	Elevated screen and flow split				$ 611,606.00
4.5.1	Supply and install 6 x concrete footings @ 1m3 each	m3	6	$ 850.00	$ 5,100.00
4.5.2	Supply and install base I columns (4m high) bolted to footings (fittings inc) 380 PFC (38	m	24	$ 4,704.00	$ 112,896.00
4.5.3	Supply and install cross members (5m long) (fittings inc) (75 x 75 x 8mm)	m	30	$ 945.00	$ 28,350.00
4.5.4	Supply and install I beams (fitting inc) 380 PFC (380 x 150)	m	30	$ 6,076.00	$ 182,280.00
4.5.5	Supply and install I column extension (1.5m high) (fittings inc) 380 PFC (380 x 150)	m	12	$ 3,528.00	$ 42,336.00
4.5.6	Supply and install cross members (2m long) (fittings inc)	m	24	$ 756.00	$ 18,144.00
4.5.7	Supply and install I beams for top platform 380 PFC (380 x 150)	m	20	$ 9,800.00	$ 196,000.00
4.5.8	Supply and install mesh plating at to of platform (expanded mesh)	m2	25	$ 540.00	$ 13,500.00
4.5.9	Supply and install handrail (fittings inc)	m	26	$ 500.00	$ 13,000.00
4.6	Odour control - carbon filter				$ 15,020.00
4.6.1	supply and install concrete surround for filters (2 x 3 x 1.5 @ 150mm thick) 20 Mpa inc rebar and formwork	m3	1	$ 1,020.00	$ 1,020.00
4.6.2	Odour Filter	ls	1	$14,000	$ 14,000.00
5	Landscaping & Entrances				$ 15,750.00
5.1	supply and install safety fence	m	50	$ 265.00	$ 13,250.00
5.2	supply and install safety fence human gateway	m	1	$ 2,500.00	$ 2,500.00
6	Piping, Pumps and Filtration				$ 144,338.13
6.1	Supply and install 316 SS 300mm pipework inc fittings, brackets, flanges, 90 deg angles and tees	kg	3700	$ 9.75	$ 36,075.00
6.2	Supply and install 316 SS 600mm pipework inc fittings, brackets and flanges and 90deg angle	kg	0	$ 9.75	$ -
6.3	Supply and install 316 SS 600mm to 500mm reducers	No.	2	$ 1,300.00	$ 2,600.00
6.4	Supply and install 316 SS 500mm pipework inc fittings, brackets and flanges	kg	297.5	$ 9.75	$ 2,900.63
6.5	Supply and install 5kw pumps	No.	2	$ 25,000.00	$ 50,000.00
6.6	Supply and install Fittings	No.	1	$ 20,325.00	$ 20,325.00
6.7	Valves, fittings bends 100mm	LS	1	$ 30,000.00	$ 30,000.00
6.8	Pipework 100mm	kg	250	$ 9.75	$ 2,437.50

7	Extraordinary Construction Costs				$ 25,600.00
7.1	Supply and install lighting, connections and fittings inc	No.	10	$ 1,000.00	$ 10,000.00
7.2	emergency switch for pump	No.	3	$ 200.00	$ 600.00
7.3	Flow meter and control valve (300mm)	No.	1	$ 5,000.00	$ 5,000.00
7.4	Supply and install isolation valves (100mm)	No.	4	$ 1,000.00	$ 4,000.00
7.5	Supply and install isolation valve - gate SS (300mm)	No.	2	$ 3,000.00	$ 6,000.00
8	Electrical				$ 154,000.00
8.1	Cables	No.	10	$ 1,000.00	$ 10,000.00
8.2	MCC	No.	1	$ 20,000.00	$ 20,000.00
8.3	Instruments	No.	2	$ 15,000.00	$ 30,000.00
8.4	Telemetry	No.	1	$ 5,000.00	$ 5,000.00
8.5	SCADA	No.	4	$ 12,000.00	$ 48,000.00
8.6	Radiolink	No.	1	$ 15,000.00	$ 15,000.00
8.7	Software	No.	1	$ 20,000.00	$ 20,000.00
8.8	Install	No.	2	$ 3,000.00	$ 6,000.00
9	Fees				$ 195,075.28
9.1	Design Fees 6%	%	0.06	$ 1,625,940.95	$ 97,556.46
9.2	Commissioning		1	$50,000	$ 50,000.00
9.3	AS Builts		1	$15,000	$ 15,000.00
9.4	MSQA		0.02	$ 1,625,940.95	$ 32,518.82
				Total	$ 1,821,016.23
				15 % contingency	$ 273,152.43
				Final value	$ 2,094,168.66

Appendix G

Risk Register

Risk Register

Project Name: Mangawhai Balance Tank
Project Number:1-1492.07
Client: Kaipara DC
Prepared by: A Springer (revised by Eros Foschieri)
Version 2
Updated: 17 September 2020

	Risk	**Description**	**Party with Risk**	**Avoid/ Mitigate/ Manage**	**Action**	**Risk Potential $**	**Owner**
1	**Commercial**	Project cost exceeds annual budget	KDC	Manage	WSP have undertaken a review of the option, concept level design and cost estimate. Cost estimate of $1.9 m plus 15% contingency is identified. – In Budget.	$272k (contingency)	KDC
2	**Commercial**	Project cost increases	KDC	Manage	Periodic review of project. Identify and agree changes. Request additional funding if needed.		KDC
3	**Technical**	Geotechnical requirement changes compare to 2007 survey	KDC	Mitigate	Undertaken targeted Geotech investigation. Confirm locations of construction.		WSP to do survey
4	**Technical**	Bank Stability- The stability of the bank is assumed as outside of previous survey. Risk of increased measures to maintain stable bank.	KDC	Mitigate	Include bank in geotech surveys. Identify risks.		WSP to include in survey
5	**Constructability**	Screen relocation. It is assumed that the existing screen can be relocated in a 4-6 hour window of no flow to works. If this is not possible, an additional screen	KDC	Mitigate	Plan screen move with contractor. Prepare contingency to enable come back later	$60k	KDC - Assess in design

	Risk	Description	Party with Risk	Avoid/ Mitigate/ Manage	Action	Risk Potential $	Owner
		may be required. Also condition of screen permits relocation.			approach. Or purchase new screnn.		
6	**Technical**	Odour- it is assumed that change from old to new odour systems will occur at a time of low odour generation. Else it may be required to run twin system for a period.	KDC	Mitigate	Consider timing of activity and make risk based decision.	$20k	KDC – consider in design
7	**Technical**	Tank cleaning. It is assumed that the tank can be cleaned from a single access platform, washing all debris to the sump for removal by installed pump. It is assumed that washwater is adequate flow and pressure to clean floor to prevent odour. Task is manual.	KDC	Mitigate	Get info on flow and pressure from existing washwater system. If too low, consider auto in tank cleaning, or washwater booster.	$40k	KDC - consider in design
8	**Environment/ Compliance**	Spills from PS-K. The project is to pass 30 l/s more to the WWTP in storm events. This will improve the Outfall PS situation, but may not address PS-K issue	KDC	Manage	Monitor and record high levels in PS. Confirm response plan in place to tanker excess water.	$50k	KDC
9	**Environment**	Wildlife outside of current site fence. Unknown whether any significant ecology to be considered	KDC	Mitigate	Desktop ecology review to lower risk of ecology impact	$10k	KDC – to instruct WSP
10.	**Archaeology**	Construction outside of site boundary may impact on archaeology.	KDC	Mitigate	Review scope of previous arcaelogical studies. If area is out of scope, undertake a desk top review to assess strategy	$15k	KDC

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